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MECHANIC ARTS, MANUFACTURES, GENERAL SCIENCE,

AND THE RECORDING OF

AMERICAN AND OTHER PATENTED INVENTIONS.

FEBRUARY, 1831.

AMERICAN PATENTS.

LIST OF AMERICAN PATENTS WHICH ISSUED IN OCTOBER, 1830.

With Remarks and Exemplifications, by the Editor.

(Concluded from page 16.)

91. For improvements in *Machinery used in Steam Navigation;* Franklin G. Smith, Lynchburg, Campbell county, Virginia, October 12.

Plates to accompany the specification of this patent are in the hands of the engraver.

92. For an improvement in the *Mould or Instrument for Pressing Pine Apple Cheese;* Myron Norton, Goshen, Litchfield county, Connecticut, October 13.

Instead of the netting usually employed to mark the lines upon pine apple cheese, moulds are to be made, of wood or metal, cast iron being preferred. Upon the insides of these moulds the requisite pattern is formed, by carving or otherwise. The moulds are made in three parts, and, when used, are confined together by proper bands. A tubular opening is left at the lower part of the mould, to fill it with curd, and into this a follower is fitted for the purpose of making pressure.

The claim is to "the substitution of the mould of metal, or wood, carved, or cast in manner and form described; and the manner or principle of giving the stamp or impression in the cheese by said

mould, at the time and in the process of pressing, thereby superseding, and eluding the use of the net formerly used for giving the impression."

Although we are impressed with the idea of having seen pine apple cheeses, the pattern of which had evidently been given by the form of the mould, we are not able to assert it as a fact. We, however, have seen many cheeses made in moulds in which devices had been carved; and they are quite common in some countries. The present patent, therefore, must stand upon the claim of the particular pattern of the mould, being that of a pine apple.

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93. For an improvement in the mode of *Constructing the Fancy Card of the Carding Machine;* Phineas L. King, of Sparta, and Enoch Blasdel, of Lawrenceburgh, Dearborn county, Indiana, October 14.

(See specification.)

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94. For a *Washing Machine;* John Freeman, Senate, Cayuga county, New York, October 14.

There is a trough into which the clothes are to be put. Within this trough are two carriages, placed side by side; the lower sides of the carriages are furnished with fluted rollers, and they are driven alternately backwards and forwards by means of a crank. The clothes being placed within the trough, the carriages are put in motion, and the action of the rollers is to produce the desired effect.

"I claim as my improvement, the principle, and the moveable carriages with fluted rollers, as new, and heretofore unknown and unused."

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95. For a *Revolving Steam Washer;* James Barnes, Kingston, Luzerne county, Pennsylvania, October 14.

This "Revolving Steam Washer" is a common barrel churn, with pins projecting through one of the staves into the barrel, to raise the clothes as the barrel revolves, and cause them to fall down into the suds. What constitutes it a *steam* washer, or what it possesses of novelty, would be news to us.

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96. For a *Machine for Sawing Felloes* for the wheels of carriages; Alvan Colbry, Sharon, Windsor county, Vermont, October 15.

Several patents have been taken for machines for sawing felloes. The present machine differs but little from some which have preceded it, and the only thing claimed as new, is the method of returning the carriage after the felloe is sawed. The plank to be sawed is placed upon a carriage, confined by a pin at the centre of the curvature of the felloe. There is a rack upon the lower side of

the carriage, and a pinion taking into this rack causes the carriage to advance; it is made to return by throwing this pinion out of, and another which operates in the reversed direction, in gear; a kind of movement common in machinery.

It frequently happens that after examining the papers and models in the patent office, applicants for patents find that they have been anticipated in their inventions, and therefore omit a part of the claims they had intended to make. We do not know that this was the case in the present instance, but from the smallness of the pretensions set up, it might fairly be inferred. The general principle of the machine has been so long known, as to have become public property.

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97. For an improvement in the *Saw Set;* Ebenezer Whiting, Berkshire, Tioga county, New York, October 15.

(See specification.)

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98. For a *Machine for Spreading Lime, Plaster, &c. on Land;* Andrew Krauss and Joel Krauss, Upper Milford, Lehigh county, Pennsylvania, October 16.

The lime, or plaster, in powder, is put into a wagon constructed for the purpose. Across the hinder part of the bed of the wagon, near the tail board, there is an opening extending from side to side. A roller fixed upon gudgeons, below the wagon bed, nearly fills up this opening. On the end of the axle of one of the hind wheels a pulley is placed, from which a band extends to another pulley on the axis of the roller, to cause it to revolve; the axis of the hind wheels revolves with them, for the purpose of communicating this motion. As the roller turns, it draws after it a portion of the article to be spread upon the land. The claim is to "the machine as above described, for spreading lime, plaster, &c. on land."

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99. For a *Machine for Washing Clothes;* William H. Brainard, of Haddam, and Chauncey B. Bulkley, of Chatham, Middlesex county, Connecticut, October 16.

A trough is made to contain the articles to be washed; dashers are caused to vibrate in this trough, by means of two levers, worked like pump handles, one in each hand. The specification contains about as many pages as we have devoted lines to the description; we, however, will afford room to the claim, which is as follows.

"What we claim as new in the above described machine, is the arrangement of the various parts which constitute the same, in the manner above specified, and the application thereof, and of the powers and principles embraced in the operation of said machine, in the form and method above set forth, for the purpose of washing clothes."

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100. For an improvement in the *Production of Light,* by a combination of liquids; Isaiah Jennings, City of New York, October 16.

This patent is taken for a material which is to be substituted for

oil in common lamps. The material is a mixture of alcohol and spirits of turpentine.

"To produce light from alcohol and spirits of turpentine, mix equal or unequal parts of each, agitate them that they may mix together; let them stand awhile, and the alcohol will be combined with a small quantity of turpentine, and the remainder will be separated; draw off the alcohol, and the small portion of turpentine combined, which is about one-eighth part, and it will be ready for use.

"I claim the admixture of alcohol with spirits of turpentine, and its application to common lamps, with or without wicks."

We have seen the above mixture in combustion in an Argand's lamp. The flame was clear, dense, and brilliant. The light may be made greatly to exceed that from oil, without the escape of any smoke; and there is not the slightest odour of the turpentine. The patentee says the mixture is as cheap as spermaceti oil, and that he is making arrangements which will enable him to afford it at a cost considerably below that material. The wick is scarcely blackened by the combustion; there is no dripping from the lamp, and no grease.

Chemists knew the fact that alcohol and spirits of turpentine would combine, and burn with a bright light; but we are not aware of their having been proposed to form an article for the supply of lamps, and one which might be advantageously employed in domestic economy. The patentee has used this composition with a wire wick, and has found it to answer well. Fibrous asbestos would probably be preferable, but this is a point of mere curiosity, as cotton wick is always at hand, and none better need be desired.

The friends of temperance will not object to the burning of alcohol.

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101. For an improvement in the *Grist Mill;* Ephraim Griswold, Truxton, Courtland county, New York, October 16.

The runner of this mill is made conical, something like the common steel mill. This is to fit into a hollow conical piece, which forms the bed. The runner and bed are to be made altogether of stone, or they may be formed in part of cast iron, with pieces of burr stone fastened on them by screws.

The axis of the runner is placed horizontally, and an opening is made through the side of the hollow conical piece, to feed the mill stones. This opening is near the inner, or small end, of the cone; the termination of which is not to be in a point, but in a segment of a globe.

"The invention here claimed is the general construction of the mill as above described; particularly in the manner of making the runner and bed of stone, or of burr blocks screwed on cast iron for that purpose."

The general construction is not new. The conical form, the feeding in the manner described, and the making such mills of stone, are circumstances in all of which the present patentee has been anticipated. What he more particularly claims, the screwing of burr blocks to iron, is, we apprehend, the only point of novelty.

102. For an improvement in the mode of making *Glass Door Knobs;* Deming Jarvis, Boston, Massachusetts, October 19.

These knobs are perforated in the usual way, to receive the spindle, which is to be square. A square cavity, about a quarter of an inch deep is sunk at each end of the knob, to receive a square collet, which will prevent the knob from turning. In all other respects the knob is made in the common form.

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103. For an improvement in the *Manufacture of Oil from the Sun Flower;* Charles A. Barnitz, Spring Garden, York county, Pennsylvania, October 20.

This *improvement* consists in following the old mode of hulling, breaking, and pressing seeds to obtain their oil. There is not the slightest pretension to novelty, but it is presumed that the patentee simply means to secure to himself the right of doing that which is known all over the country, and has been practised both here and in Europe.

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104. For an improvement in the manner of *Manufacturing Brads from Iron Plates;* Edmund Gamman, Gorham, Cumberland county, Maine, October 20.

A strong iron shaft is to have projecting rims upon it, around which rims are placed steel cutters, in number from six to twenty. The cutters are tapered in reversed directions, alternately, according to the taper of the brad. The stationary, or bed cutters, are to be made to vibrate by means of cams. The particular construction of this part of the machine does not appear in the drawing, and is very obscurely described in the specification. The iron plates are to be carried towards the cutters by feed rollers.

The whole machine appears to be considered as "the improvement," as there is no particular claim to any part. Circular brad and nail machines, with the revolving cutters fixed in the manner described, have been repeatedly tried; they have not however been found equal to the ordinary vibrating machine, nor do we believe they can be made so.

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105. For a combination of machinery for *Thrashing Grain, Shelling Corn, Cutting Straw, and Grinding Provender;* Benjamin D. Beecher, Woodbury, Litchfield county, Connecticut, October 20.

This is a sort of *omnium* machine, the novelty of which consists in uniting several different machines together.

The claims made are to "the particular form of the beaters; the manner of making the concave; driving the feeding roller by the main band; the apron by the main shaft; and the mode of combining the several pieces of the machinery."

The cylinder has iron beaters on it which are bent in the form of a V; that, in beating, the angular point may first meet the grain to be

thrashed; the hollow segment, or concave, is formed of thin plates of iron, placed between strips of wood. The shelling part is made like the well known corn sheller, consisting of a circular disk with teeth on its side. Towards the centre of this wheel cutters are placed, for cutting straw; when thus used, a trough is added to feed from. Still nearer the centre is to be a furrowed, cast iron plate, running against a corresponding plate, for grinding provender. We have heard of instruments furnished with so many conveniences that it was quite inconvenient to use them; this objection, we suspect, will lie against the contrivance of which we have spoken, and it will not stand alone, as "the *particular* form of the beaters," and some other *particulars* named, are by no means new.

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106. For a machine for *Sawing Felloes for Carriage Wheels;* David D. Hanson, Weare, Hillsborough county, New Hampshire, October 20.

This machine bears a strong resemblance to that described, No. 96. There is, of course, some difference in the arrangement. The improvements claimed are the manner in which the part called the sweep is constructed, together with the vice and gauge pullies. These particular parts we do not think it necessary to describe, not perceiving any thing in them worthy of special notice.

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107. For an improvement in the *Water Wheel;* Henry Overvill, Richland, Oswego county, New York, October 21.

This water wheel is similar to one which we described in our last volume. The leaves, or buckets, are hung like shutters, and are intended to open by the force of the current, when moving with it, and to close in their opposite motion. Such buckets, variously hung, have been reinvented over and over again. The contrivance is one of the first suggestions to the minds of those who are in search of a current wheel, and who are uninformed respecting previous failures in the same search. The phantom is destined to be again called from the shades, and again to disappoint the exorist.

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108. For an improvement in the machine for *Carding Wool,* and other fibrous materials; Calvin Wing, Gardiner, Kennebeck county, Maine, October 21.

This carding machine has been fairly tested, and is highly spoken of, both as regards the goodness of the work performed by it, and the saving of labour, which is said to be equal to more than one-half. We cannot describe its various arrangements, intelligibly, without a plate, and therefore will not attempt it, particularly as we may hereafter be enabled to give it with the requisite illustrations.

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109. For an improvement in the *Water Wheel, by Casting it in one entire piece; and also in the mode of Casting the*

same; Calvin Wing, Gardiner, Kennebeck county, Maine, October 22.

(See specification.)

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110. For an improvement in the *Mode of Boring the Earth for Water,* and for other purposes; William Morris, Jr. and Jabez Spinks, Kenhawa county, Virginia, October 22.

The principal object of this machine, we are told, is the employment of horse power, which is applied as in the common horse mill. The horse being geared to a sweep attached to a vertical shaft.

Over the well, or place to be bored, a scaffolding is raised consisting of four poles 40 or 50 feet in length, and placed rectangularly, suitable cross pieces being used to bind them together. The drill is made to rise and fall by means of a horizontal shaft acted upon by the periphery of the horizontal wheel, turned by the horse; and by means of a rope passing over a pulley at the upper part of the scaffold, the auger may be withdrawn.

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111. For improvements in the construction of the *Water Wheel,* and in its application to the driving of machinery, by the reaction of water; Calvin Wing, Gardiner, Maine, October 22.

(See specification.)

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112. For a *Bedstead, called a Metamorphosic Alleviator;* Jonathan Lowe, Vienna, Oneida county, New York, October 25.

This is one member added to the family of bedsteads designed for the accommodation of persons confined to bed. We have recently noticed two patents, having the same object in view, and a volume might be filled with descriptions of similar contrivances. In the case before us, the platform, or bottom of the bedstead, is divided into three parts; the head part is made to elevate, and the foot part may be depressed, there being joints in the side rails for that purpose. The legs, at the foot, are made capable of bending underneath to allow of this depression. The centre part of the side rail is furnished with legs, independent of the head and foot posts, to sustain the bedstead when the latter are off the floor. Rollers, ropes, pullies, &c. are used to give the required elevation or depression.

There are so many ways of effecting the purposes intended by this bedstead, and they have, indeed, been so frequently effected, that there ought to be something special in the construction of an apparatus of the kind for which a patent is taken. The present patentee appears to consider as new, all that he describes, as, if there is any thing which can be called a claim, it is in the following words.

"For all which improvement in the construction and use of the common, French, field, high post, and other bedstead, the inventor most respectfully solicits the patronage of the proper authorities, by granting him letters patent, agreeably to the acts of congress in such case made and provided."

113. For an improvement in the *Machine for Inking Forms of Type*, or letters, &c. when worked, or printed on a common hand printing press; Samuel Fairlamb, City of New York, October 25.

The patentee has occupied eleven pages in the description of his apparatus, with an additional page of references to the drawing. The claim is of considerable length, and would not be understood if given alone. Since the patent obtained by Mr. W. J. Stone, in Oct. 1829, three or four differently constructed inking machines have been patented, which have been duly noticed. The present is less complex than some of its predecessors, but it has no superiority in this particular over that of Mr. Stone. The only true test of comparative merit, is a fair trial, which has not yet been given to Mr. Stone's machine.

LIST OF PATENTS WHICH ISSUED IN NOVEMBER, 1830.

With Remarks and Exemplifications, by the Editor.

1. For a *Machine to Pick up Apples from the Ground*, under the trees; Samuel Laning, Camden, Gloucester county, New Jersey, November 1.

This machine is to be driven on by handles formed like those of a wheel barrow. A drum, or cylinder, stands in the place of the wheel, extending across the machinery, and being about 16 inches long. The heads of this cylinder form projecting rims extending three inches beyond the cylinder; these rims serve as wheels to the picking machine, and sustain the cylinder at the distance of three inches from the ground. Pointed wires serve as pickers, by running into the apples. A comb above the cylinder removes the apples from the pickers, and conducts them down into a basket suspended to receive them, which, when filled, is to be replaced.

The claim is to "the employment of a cylinder with pickers for the purpose of picking up apples from the ground, and the comb, or slats, for taking the same from the pickers, and delivering them into a basket, in the manner, and for the purposes herein described."

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2. For an improvement in the *Apparatus for Boring the Earth for Water;* Levi Disbrow, City of New York, November 1.

(See specification.)

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3. For a *Machine for Cutting Tenons on Carriage and Wagon Spokes;* Andrew P. Smith, Cornwall, Litchfield county, Connecticut, November 1.

The patentee has described this machine at much length, so that we think the description is obscured by its minuteness. The tenons it appears are to be cut by a jointer furnished with an askew iron. The shoulder is to be cut by a saw extending from the angle of the

jointer a little above the face of the iron. The jointer is made to traverse between horizontal cheeks, by a crank and pitman at one end of the frame. There are certain other appendages to hold the spoke, and regulate the cutting. The mode of operation differs from that of several other machines for the same purpose, but we do not perceive its points of superiority. The whole apparatus is patented, no claim being made.

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4. For an improvement in the *Lever Press;* Hazard Sherman, Scriba, Oswego county, New York, November 1.

This press acts upon the familiar principle of a combination of levers. There is a bed piece, or sill, from the ends of which rise two uprights with slots and holes to fix the ends of the levers, and form their fulcra. The patentee says, "what I claim as new, and as my own invention and discovery in this press, and for which I now ask an exclusive privilege, is the particular method of applying the increased power obtained by the multiplication of levers bearing upon each other, as described in the above specification, and illustrated in the drawing."

We are quite unable to ascertain in what the discovery here claimed consists; but we think there would have been just as much wisdom in claiming the *increased friction*, as the *increased power*.

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5. For an improvement in the *Machinery for taking the Wool from the Wool Carding Machine;* Charles Atwood, Middletown, Middlesex county, Connecticut, November 1.

"This improvement consists in placing a trumpet formed tube, having a rotary motion, at or near the end of the doffer, at each end of a wide machine, or one end of a narrow one, at a distance of about two inches from the face of the doffer, with its centre about level with the lowest action of the comb, at right angles with the doffer. The tubes turn into stands bolted on the top of the plate of the carding machine, projecting inwards, and are motioned as hereafter described. When the wool by the natural action of the comb has formed a roll of sufficient size for a sliver, or thread, the out end is passed through the tube, to a pair of rollers placed before it, having a speed sufficient to take it away. The lower of these rolls is on a shaft passing across the carding machine, having its bearings cut into the top of the plates, with two rolls on it of about four inches in diameter, and six inches long, placed directly before each tube, with their upper surface level with the centre."

We have copied so much of the specification to afford a general idea of the plan pursued; and can do no more without giving the whole with the drawings. The latter are but very indifferently executed, but still suffice to make known the *general* arrangement of the machinery.

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6. For an improvement in the *Machine for Winding the Slubbing, or Roving made from the Carding Machine, upon*

separate Spools, or Bobbins without Heads, called the Conical Spool Winder, for slubbing from the card; Charles Atwood, Middletown, Middlesex county, Connecticut, November 1.

We cannot attempt a description of this machinery, without giving drawings; nor can we furnish the claim of the patentee, as he does not make any.

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7. For a *Method of Moulding and Drying Brick;* Charles Vasser, Poughkeepsie, Dutchess county, New York, November 1.

The brick moulds are to have projecting edges of steel, and the stock is to be of metal, or covered with metal. Each brick when moulded is to be turned out upon a smooth board, a little larger than the face of the brick. These boards, with the bricks upon them, are to be arranged upon shelves in a drying shed. The roof of this shed is to be close, and the sides furnished with falling shutters to keep out the rain, &c. when required.

The foregoing is the substance of "Vasser's new and useful invention for moulding and drying bricks." There is no claim. We are not quite sure that moulds lined, as we have seen them, with iron, are not as good as those above described. Sheds with close roofs and side shutters are not new, and would be generally used were not economy too much considered. The plan of a separate board upon which to dry every brick, we suppose is new, but doubt its adoption.

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8. For an improvement in the *Plough;* Samson Felton, Huntington, Huntington county, Pennsylvania, November 1.

No attempt is made in the specification to designate any thing in the form of this plough, that is different from that of other ploughs; but the mould board and land side are to be in part of cast iron, and in part of wood. The share is to be of wrought, or of cast iron. The claim rests upon these circumstances, and upon the manner of putting the whole together.

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9. For a machine for *Thrashing Grain and Shelling Corn;* Edward Thurston, City of New York, November 1.

This machine is to have a cast iron cylinder, which is to be fluted, or ribbed, from end to end. There is also to be a hollow segment similarly fluted. This hollow segment is to be borne up against the roller by spiral, or other, springs, and is fixed upon a frame, to which a weight is hung, to co-operate with the action of the springs. The claim is to the combination of the balance and spring bed, and to the entire cast iron cylinder.

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10. For a mode of *Preserving Rope and Cordage;* Amos Salisbury, Troy, New York, November 1.

If we understand this patent, tarred ropes must no longer be made without first acquiring a right from the above named gentleman.

He says, "my improvement consists in saturating the rope or cordage, or the material of which it is made, with oil, fat, or other *unctuous substance*, or applying such quantity of oil, or unctuous substance, as shall be deemed necessary to answer the purpose intended."

It will behoove Mr. Converse, the townsman of the patentee, to see that, in his candle factory, the workmen in his employ keep clean hands, or he may be fined for having his ropes saturated with tallow.

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11. For a *Machine for Facilitating the Washing of Ores and Alluvial Soils*, and the extraction of metallic substances and precious stones from ores, earth, sand, or other matter in which they may be found. Issued according to a special act of congress, passed May 28th, 1830, to Vincent de Rivafinole, late of England, but now of Mechlenburg county, North Carolina, for himself, and as attorney in fact for Charles Harsleben and William Davis, of the kingdom of Great Britain, November 1, 1830.

We have seen this machine in actual operation, and on a former occasion adverted to it in terms of commendation.

The apparatus consists of a conical tub, or other suitable vessel, placed vertically. A double shaft passes down the centre of the tub, which carries metallic dashers, or agitators, which are turned by means of a crank. The shaft is made double, consisting of a solid rod turning in a tube, to carry two sets of dashers with different velocities. The pulverized mass intended to be washed, is put into the tub, with some water. On turning the dashers with a proper velocity, the water will be thrown towards the outside of the tub, and the contents will assume the form of an inverted cone, to the lower end of which gold, silver, or other weighty articles will descend. There is under the centre of the tub, a metallic chamber, and a valve, which, when opened by means of a lever, will allow the heavy substances to descend into the chamber, and upon opening a second valve, they will fall from this chamber into any vessel placed below it.

When the agitation has been continued a sufficient length of time, the valve is opened, but the agitators are still kept at work. The chamber fills with a portion of water and with the heavy substances; the valve is immediately closed, and the contents of the chamber taken out; when the metallic or other ponderous matter which the earth contained, will be found therein.

The claim is to the double agitators, and to double or treble valves, to allow the washed materials to be collected.

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12. For *Lock Paddle Wheels*, for propelling canal and other boats; H. L. B. Lewis, Buffaloe, Erie county, New York, November 2.

The paddle wheels described in Mr. Lewis' specification, are to have the buckets hinged. The shaft, or middle part of the wheel is

to be a cylinder, or drum, to which the rims of the wheels are to be attached, leaving no place for the escape of water, either at the sides or towards the centre of the wheel. In order to enable the buckets to fill with water, a space is left, between each bucket and the cylindrical drum, just sufficient to allow of the escape of air, for that purpose. The gudgeons upon which the buckets turn, are to pass through the sides, or rims of the wheels; and arms, from them, work in grooves attached to the framing, or are operated upon by cams, or pins, to cause the buckets to lock and unlock, close or open, at the moment desired, and to assume an angle which may be thought best.

The claim is to "the locking or unlocking of the floats at any point required;" to the forming of the wheel with a cylinder, or drum, as described, with solid or close sides to prevent the escape of water, either laterally or vertically; and to the edges or rims of the wheels projecting beyond the outer edges of the paddles, for the purpose of checking, or preventing the agitation of the water, in order to prevent the banks of canals from washing.

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13. For a *Sawing and Planing Machine;* Thomas Bloomer, City of New York, November 3.

This may be a very good machine, but it is not explained with sufficient clearness to enable us to determine this point. A plane, of the ordinary construction it seems, is to slide between cheeks, or guides; a crank, with a pitman, or shackle bar, being employed to give it motion. It is intended to plane up short stuff for boxes, &c. There is a feed roller which is to move the pieces to be planed.

Saws of the circular kind, we are told, may be driven by the same machinery. The claim is to "the construction and application of machinery in cross cutting and planing boards for boxes and other purposes." The sawing apparatus is represented in a separate drawing, but is not described in such a way as to enable us to judge of what is intended to be claimed, as it consists of circular saws moved in the ordinary way, the frame work being so arranged as to adapt it to the purposes to which it is to be applied.

[TO BE CONTINUED.]

SPECIFICATIONS OF AMERICAN PATENTS.

Specification of a patent for an improvement in the mode of constructing the Fancy Card used in Wool Carding Machines. Granted to PHINEAS L. KING, *of Sparta, and* ENOCH BLASDEL, *of Lawrenceburgh, Dearborn county, Indiana, October 14th,* 1830.

THE carding machine to which this improvement is applied, is constructed in every respect like those in common use. The improvement which we claim as our invention, is in the *Fancy Card* for cleaning the main cylinder and doffer. Instead of the usual fancy card, (which is of short wire,) the one we have invented and applied to use, is made of needles, or long, steel, pointed wire teeth,

properly secured in leather, behind, by wire, or any other suitable substance.

Our fancy card, constructed of needles, or long, steel, pointed wire teeth, not only does the business of the common fancy card in a superior manner, but it cleans the main cylinder and doffer, without wearing the cards, like the common fancy card.

This improvement can be applied to all wool carding machines.

The *invention* here claimed, is that of making fancy cards, (as before described,) of needles, or long, steel, pointed wire teeth, or long teeth made of common wire properly secured, instead of the short toothed fancy cards, now in use. PHINEAS L. KING.
ENOCH BLASDEL.

Specification of a patent for the making of Reaction Water Wheels entire, of one single piece of cast metal; and the mode of forming the pattern so as to accomplish this end. Granted to CALVIN WING, *Gardiner, Maine, October* 22, 1830.

To all whom it may concern, be it known, that I, Calvin Wing, have invented a water wheel, the two rims, or ends of which, with the floats or buckets, consist of one entire piece of cast iron, or other metal; and also a mode of casting the same, as well as other wheels intended to be moved by the reaction of water. The construction of the wheel invented by me, is fully described in an instrument of writing deposited in the patent office of the United States, for the purpose of obtaining a patent for the manner of constructing the same, and for the mode of applying it to various uses. And I do hereby declare that the following is a full and exact description of the manner in which the pattern of my said wheel is made and moulded, in order to its being cast in one entire piece.

I cause a flask to be made in three parts; the depth from the top to the bottom of the middle section of the flask being equal to the width of the floats, or buckets, between the rims, or ends of the wheel. In moulding the wheel, the pattern of one of its ends is placed upon the mould board, with its inner side downwards, that which I call its open end should be preferred; one of the exterior parts of the flask is then placed over it, and filled with sand in the usual way. It is then turned up and the centre part of the flask placed over it. The patterns of the floats are then properly arranged around the moulded end, the patterns being prepared with dowels, or pins for that purpose. When this part of the flask has been filled with the casting sand, the pattern forming the other end of the wheel is laid upon the floats, and moulded in the third part of the flask.

When the moulding has been thus completed, in withdrawing the pattern, the upper part of the flask is removed, the pattern taken out of it, and those of the floats also removed from the middle of the flask; the end of the flask is then replaced, and the whole mould

reversed, when the end first moulded is taken out. On replacing the end flask, the whole is ready for receiving the metal.

As in my reaction wheel the whole force to which it is subjected is sustained by one of its heads, through the centre of which the shaft passes, whether the same be used vertically, or horizontally, it is necessary to give considerable strength to that head, or end. But were this done by making the pattern of such head of the required thickness, there would be great danger of the cracking of the metal from unequal contraction in cooling, I therefore cast a centre piece, or hub, separately from the wheel, and secure it thereto by suitable bolts or screws.

What I claim as my invention, is the making reaction wheels entire, of one single piece of cast metal, and also the forming the pattern of my reaction wheel, so that the floats and the two heads may be moulded in a flask divided into three sections, in the manner, or upon the principle hereinbefore described, by which the same, or other wheels intended to operate as reaction wheels, may be cast in one entire piece. CALVIN WING.

Specification of a patent for an improvement in the construction of the Water Wheel, and in its application to the driving of machinery, by the reaction of water. Granted to CALVIN WING, *Gardiner, Maine, October* 22, 1830.

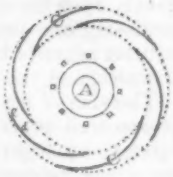
To all whom it may concern, be it known, that I, Calvin Wing, have invented or discovered certain improvements in the construction of the water wheel for driving machinery by the reaction of water, and in the manner of applying the same, either to vertical or to horizontal shafts, and also in the application of water thereto, by which inventions or discoveries, the difficulties hitherto experienced in the construction of that kind of mill usually denominated Barker's mill, and the various modifications of the principle upon which it acts, which have been hitherto essayed, are so far obviated, as to render the same more economical and efficient than the ordinary modes of applying the power of water as a motive force. And I do hereby declare that the following is a full and exact description of my said improvements, reference being had to the drawings which accompany this specification.

The water wheel which I use is generally cast in one entire piece, in the manner described in a certain instrument of writing, deposited by me in the patent office of the United States, for the purpose of obtaining a patent for making the same of one entire piece, and for the manner in which this is effected. The wheel, however, may be made in separate parts, either of wrought or cast iron, or any other suitable material.

Fig. 1, is a bird's eye view of the wheel, the end to which the shaft is to be attached, at the perforation, A, being downwards, and the open end, or rim, upwards. To show the floats, the upper rim, which covers them, is not represented. The lines, C, C, ex-

hibit the form of the floats, or buckets, and the manner in which they are arranged. The diameter of this wheel, and the width of the floats between the two heads, and the depth of aperture between the floats, will, of course, be varied, according to the quantity and head of water which can be obtained, and the purpose to which it is to be applied. The curved floats, it will be seen, are made to lap over each other; and, in practice, I have found that the proportion in which they do so is a point of considerable importance. The proportion between the aperture and the lap which I have found to be the best, is as three to two; that is, for every inch of aperture, measuring from float to float, at the point where the water escapes, the floats should pass each other one and a half inch. It will be manifest that a slight deviation from this proportion, in either way, will not be attended by any sensible loss of power. I have found, however, that any considerable deviation is injurious. The mechanic should be careful so to construct his wheel that the part of the aperture seen at *e* should be less than that seen at *d*.

Fig. 1.



Upon the inner edge of the rim there is a projecting fillet, or flanch, which may be seen in the section D, of this wheel, at the lower part of Fig. 3, with this difference, that said fillets or flanches are to be made flat, as they are to work against, and not within, each other.

What I claim in the construction of the above described wheel, is the arrangement of the floats, or buckets, within the narrow rim forming the open head of the wheel, and their passing, or lapping over each other, in the manner described, by which the water is delivered tangentially from the wheel, or nearly so, whilst it is subjected to but little friction, or obstruction from other causes.

Wheels so constructed I apply either on a horizontal or vertical shaft, and either singly or in pairs, according to circumstances.

Fig. 2.

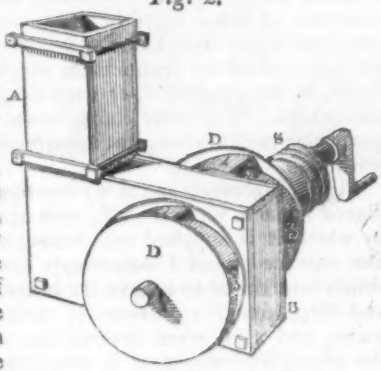


Fig. 2, represents the double reacting wheel, placed on a horizontal shaft, in which manner I use them whenever it is desirable to obtain motion from such a shaft. S, is the horizontal shaft, A, the penstock, and B, the cistern, the heads, or sides of the cistern, are formed in whole, or in part, of cast iron plates, securely bolted together. D, D, are two water wheels, one of which is placed on each side of the cistern, B, their open ends standing against the side plates of the cistern, which are perforated, having openings in them equal in size to those on the

heads of the wheels, and being concentric with them. The fillet, or flanch, upon the rim of each wheel, is made flat, and is fitted to run as closely to a similar fillet or flanch on the cistern head as may be, without actually bearing against it, so as to prevent too much waste of water, and yet to avoid friction by touching it.

The size of the orifices in the wheel and cistern plates is a point of essential importance, and should greatly exceed what has been heretofore thought necessary. Their area should be such as to permit the whole column of water to act unobstructedly on the wheel, whatever may be the height of the head. I have found that for a head of four feet, the area of the orifice should never be permitted to fall short of three times the number of square inches which can be delivered by all the openings of the floats. The penstock, or gate way, should also be sufficiently large to admit freely the same proportionate quantity of water through every part of its section; say about three times the area of the orifices of the cistern heads and wheels.

For a greater head these openings must be proportionally increased, or the whole intention will be defeated, as it has been from want of attention to this principle, that numerous failures have occurred in the attempt to drive mills by reaction wheels. Whenever it is practicable, the limit which I have given should be exceeded, but never can be diminished without loss.

Instead of using a trunk, or penstock, smaller than the horizontal section of the cistern, B, I extend the sides, front, and back of said cistern, upwards in one continued line, whenever the same can be done; the cistern and penstock then form one trunk, of equal section throughout.

When greater power is requisite, I place other reacting wheels, or pairs of wheels, upon the same shaft, so that each may operate in the same way.

What I claim as new in the foregoing modification of my invention, as represented in Fig. 2, is the placing of two or more of my reaction wheels against reservoirs, or cisterns, formed of plates of cast iron, or other suitable substance, in the manner, and for the purposes above designated. I also claim as my improvement the enlargement of the channels for supplying water to the buckets or floats, in the proportion, or exceeding the proportion which I have designated. The latter claim, however, not being confined to this particular modification, but appertaining to my wheel, in all its applications.

Fig. 3.

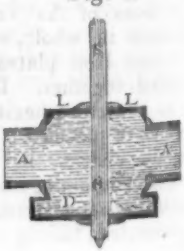


Fig. 3, represents one of my reacting wheels, placed upon a vertical shaft, with the cistern by which it is supplied with water; to this is also attached what I denominate *the lighter*, which is intended to relieve the lower gudgeon and step, from the pressure of the column of water, and also, when desired, the weight of the wheel, and whatever is attached thereto. The whole being shown in a vertical section through the axis of the wheel.

A, A, is the cistern of water, the construction of which, with its penstock, may be seen at B, A, Fig. 4.

D, the wheel, the flanch on its upper side passing within the edge of that on the lower plate of the cistern.

L, L, the *lighter* for relieving the gudgeon and step of the shaft and wheel from the downward pressure.

The lighter is a circular plate of iron, concentric with the wheel, and attached to the same shaft. Upon its lower side is a flanch, or projecting rim, fitting into an orifice in the upper plate of the cistern, in the same manner in which that of the wheel fits into the lower plate; allowing, therefore, of a vertical motion of the shaft to a certain extent, without binding upon the plates of the cistern.

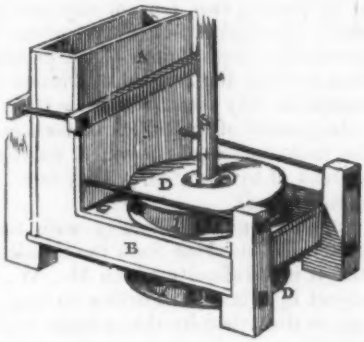
From the equable pressure of fluids in all directions, the lighter, (when equal in its area to that of the orifice of the wheel,) will be pressed upwards with the same degree of force with which the latter, (the wheel,) is pressed downwards; and if made larger, it will be pressed upwards with a greater force; and may be so proportioned as to take off the weight both of the machinery and of the water, from the gudgeon and its step.

When a single wheel is placed upon a horizontal shaft, the lighter will take the place of the second wheel, and so also in the case of any odd number of wheels, either on a vertical or a horizontal shaft.

What I claim of the foregoing, in addition to my former claims, is the application of the lighter for taking off the downward pressure when the wheel, or wheels, are placed on a vertical shaft; and for equalising the lateral pressure when placed upon a horizontal shaft.

Fig. 4, represents the double reacting wheel on a vertical shaft. A, being the penstock. B, the cistern. D, D, the wheels, revolving within the plates of the cistern in the same manner as the wheel and lighter in Fig. 3.

Fig. 4.



The upper wheel in this arrangement answers all the purposes of the lighter in the former, the orifice of which may be enlarged, if desired, with the same views.

What I claim in this last modification of my invention, is, the placing of two or more wheels on a vertical shaft; the upper wheel of each pair operating as a lighter; but with the addition of a lighter should the series of wheels consist of an odd number. CALVIN WING.

Testimonials in favour of Mr. Wing's Water Wheel.

IT affords us pleasure to insert the following testimonials of the

operation of Mr. Wing's water wheel. We have always thought the employment of the reaction wheel a very wasteful mode of applying water, as it had proved to be so in all the forms under which we have ever known it tried. Mr. Wing, however, bids fair to prove that, under the arrangements adopted by him, it will conquer all prejudices, and establish itself in the good opinion of the public, upon the basis of its real merits.

Many other testimonials have been exhibited to us, from persons worthy of all credit, both from their judgment and standing; but as they all tend to establish the same facts, we do not think it necessary to insert them.

Extract of a Letter from Alexander S. Chadwick, Esq. to the Editor. Dated Gardiner, Maine, July 24, 1830.

"In pursuance of your advice contained in your favour of the 21st May, Mr. Wing has proceeded farther in his experiments on the reacting wheel. He has put a double wheel in operation for propelling a saw mill, which, under every disadvantage attending all new experiments, gives the best satisfaction to all competent judges, and more than realizes his expectations. I do not hesitate to say, that *in all cases* of saw mills, he can save *one-half* of the water now required; in *general cases*, *two-thirds;* and, *in some instances*, *three-fourths*. There are a vast number of water rights which have been abandoned as valueless, to which the application of this wheel will give a power equal to the medium power of mill sites in the country generally.

Mr. W. has succeeded in doing away every objection heretofore existing to the reaction wheel. By the application of the *lighter*, or by placing two, four, or any *even* number of wheels upon the same shaft, (the *lighter* being used where an *odd* number is required,) he procures an equilibrium of the pressure of the column of water, and thus reduces the amount of friction occasioned by the water, which, except in very small wheels, was an insuperable difficulty. By the enlargement of the orifice of the upper wheel, or of the lighter, even the incumbency of the wheel itself may be supported by the water, instead of by the step. This last is only to be obtained from the vertical shaft.

Another great difficulty with the reaction wheel, was *want of power*. This arose from the injudicious construction of the wheel, and it is a difficulty which Mr. W. has wholly obviated. His first object is to leave the orifice so large that the column of water shall not be disturbed by that portion which is permitted to escape. Secondly, so to direct the water, as that its escape shall be as near as possible at right angles with a line drawn through the centre of the wheel; the power of reaction operating upon the wheel in a direct line with the escape of the water. This is not perfectly attainable in the construction of the wheel alone; but when it operates under water, its motion produces its own natural vacuum, the surrounding water forming a circular, elastic wall, and serves to assist in di-

recting the water in a course rather *within a right angle* from the line drawn through the centre. This tends to throw the force of reaction rather *without the centre of the aperture extending, or lengthening, the natural lever of the wheel.* Hence, all the power which water is capable of giving is obtained.

The power of reaction always exceeds the power of percussion. This proposition will appear obvious from this elucidation; viz. the power of percussion can never exceed the whole amount of head and fall, lessened by all the friction of the aperture, through which the water escapes, and the atmosphere through which it passes. The power of reaction, rightly applied, is equal to all the head and fall, not decreased by the natural friction to be overcome in the passage of the water. In addition to this, in all other wheels, some part of the head and fall is necessarily lost. Here there is nothing lost.

My object in stating, so particularly, the merits of this wheel, is to prepare you, in some degree, to understand what Mr. W. claims as his improvement.

Abstract of Col. J. Conners' Certificate.

This may certify that I have carried on the lumber business in the town of Gardiner, for 29 years; have occupied the same saw mill with the old fashioned undershot water wheel. That I have now in operation one of Calvin Wing's improved reaction water wheels; have had an opportunity to test it thoroughly, and am satisfied that under the same head and fall it operates with equal power and speed, with less than one-half the water used by any other saw mill wheel that I have been acquainted with.

I have also used one of said Wing's reacting wheels in my clothing and carding mills, and I find by experience that the back water has no perceptible effect to retard the motion or lessen the power of the wheel, if the head is increased in the same ratio, and I give it as my opinion that said wheels are superior to any now in use.

JAMES CONNERS, Jr.

Gardiner, Maine, August 24, 1830.

George Shaw & Co.

This may certify that we have had in use a water wheel called a breast wheel, which drew on seventy-two square inches of water; that it failed to carry with sufficient speed the machinery which I had attached to it. I was induced to throw aside said wheel, and to put in its place one of Calvin Wing's double reacting water wheels, and I am satisfied that the same water will do more than double the work when used on said reacting wheel, that it would do on the breast wheel.

We have also a reacting wheel in use at our other works, and find it to answer the best purpose, and are of opinion that said wheels are preferable to any other wheels now in use.

GEORGE SHAW & Co.

Gardiner, August 25, 1830.

Specification of a patent for improvements in the apparatus for Boring the Earth for Water. Granted to Levi Disbrow, *City of New York, November* 2, 1830.

Mr. Disbrow has a former patent for boring apparatus. One particular object in the present patent, appears to be the employment of bits with springs attached to them, to cause them to bore a hole larger than that of the tube through which they are passed down. The parts described are as follows.

No. 1. *The pipes for sinking in the earth*, are of cast iron, of an equal bore throughout, but of a diminished thickness, taken from the outside near the end, till it is small enough to fit into the socket formed on the next length of pipe—the socket is formed by a band of wrought iron, placed on the end of the pipe, but which, when cold, contracts, and so remains permanent. The next length of pipe is formed in the same manner, and so may be continued to any required length or depth. The joints are closed as iron joints, by driving wedges, and so resist either water or steam.

No. 2. *The pod or cylinder bit for boring the earth*, passes through the pipe. It is made of iron, pointed with steel; there is a spring on the outside, whose most disengaged state is larger than the outside of the pipe, to the end that when it gets below the pipe, it may cause a hole to be bored larger than the pipe to be received; and which is effected by the distension caused by the spring.

No. 3. *The chain and levers for forcing down the pipe.* The levers are two pieces of joist made fast to the platform by pieces of chains, or other common means. The chains have hooks on either end. One hook fastens on the socket; the other is passed with the chain round the lever, and hooks in such part of the chain, as the purchase may require, at pleasure.

No. 4. *Rods connected by crutch joints and screws.* The rods are square lengths of iron; there is a square crutch formed at each end of the length, into which one admits the other. The ends are held by screws which pass each other transversely; by this means any length of rod may be securely connected, gaining the effect both of flexibility and strength.

No. 5. *The spring chisel* is formed by a spring which confines the operation of the chisel, or punch, to the edge of the pipe. Its use is for breaking off pieces of stone which in part obstruct the passage of the pipe.

No. 6. The rock boring tools are, first, a set of chisels, or punches; second, a riming bit. It is formed by four dies of steel well bolted on a square rod, which extends below as a guide; its use is to enlarge a hole already made to any proposed size. The whole of the above tools and apparatus are used with the machine already patented to said Levi Disbrow, dated twenty-fourth March, one thousand eight hundred and twenty-five. Levi Disbrow.

Observations on a patent obtained by Lieut. BELL, *for a Percussion Lock and Vent for Cannon; and an assertion of the original claim to that invention. By* JOSHUA SHAW.

Philadelphia, January 27, 1831.

TO THE EDITOR OF THE JOURNAL OF THE FRANKLIN INSTITUTE.

SIR,—In the last December number, just received, is a notice of a patent granted to Lieut. W. H. Bell, for a percussion lock and vent for cannon. There never was a more striking instance of the natural propensity which one man has to disregard the rights of another, than is exhibited in the conduct of this gentleman, and in the use and application of the machine in question, which is not in any essential degree, or particular, different from one patented on the 24th day of October, 1828. You have observed that, excepting in the mere arrangement of the parts, *you do not think it new.* And again in speaking of the countersinking of the vent to receive the primer, which stands as conspicuously as any other part of the arrangement, you ask, *is this new.* Now it would extremely oblige one who is much interested in this matter, to be permitted to inquire if there be *any thing new* in this specification, or which did not originate with some other person, and which was not communicated to Lieut. Bell long previous to his application for a patent.

The author of these remarks was the first to discover the process of firing cannon by the means here employed, and the power of the fulminating matter to penetrate through the cavity of the vent, and to ignite the charge without the assistance of the priming wire, priming materials, or other priming powder, by the means of a machine acting upon it in precisely the same manner as in Lieut. Bell's apparatus, which is the same in principle with mine, without a single advantage being gained; except it be contended that the contracting of the vent, and the placing it on one side, constitute any; and if such be the case, the claim should be exclusively confined to them. However, it is doubtful if the first could be sustained, as a vent is only such, and has been drilled of every dimension, without any fixed rule. With respect to its location on the side, it is a very important point gained, where a lock of any kind is employed, whether it be on the percussion or the flint lock principle. But it is believed that Lieut. Bell never intended to claim these as his invention; they are, however, introduced, and that in a way very well calculated to serve a lame purpose, by qualifying a machine otherwise useless, as it would be impossible to apply it to the guns now in the United States' service. To have been consistent, this specification ought to have gone further, and have laid claim to the cannon also, since, if a mere change in the *arrangement* of the parts of a machine will suffice in the first case, it must apply with equal *certainty* in the second instance.

On first reading the account of Lieut. Bell's patent, I confess that I felt my indignation rising, and was disposed to be very angry; but

my charity for human failings has prevailed over the less kindly feelings of our nature, and has induced me to conclude that the Lieutenant did not comprehend the law on patents, and acted under the impression that the right of invention was a sort of debateable property, a something like waste lands, on which any person who felt disposed, might locate himself without asking any questions, break up the soil, and work it for his own purposes and benefit. If this be not the view taken of it by the gentleman, it will be impossible to account for his conduct in any other way, especially when the following particulars shall be made known. In 1828, or 1829, Lieut. Bell called on the subscriber for the purpose, as he said, of making inquiries respecting the various modes of preparing and applying the fulminating powders to the best advantage, as a priming for cannon. I communicated all that I knew, freely and unreservedly, and pointed out to him the various advantages and disadvantages attending its application, observing that the vents as now made were in general too large to apply it advantageously; that the reaction upon the cock at the moment of discharge was one of the principal objections, as it required the addition of a safety spring. This difficulty, I observed to him, could be easily removed, when new castings should be required, by merely drilling the vents of about half their present diameter, and that a further advantage could then be secured by making it on the side, which would free the sight. I then exhibited to Lieut. Bell one mode of doing this, not by mere explanation, but I produced and exhibited to him a working model complete, and which he examined carefully, and with manifest interest. He said it was excellent, and one of the most valuable improvements he had heard of. He expressed his surprise that I should be so ready to show it, and said that it could be taken advantage of to my prejudice. I told him that I did not think so, as I believed my specification covered the *principle*, and that with respect to the mere *arrangement* of the parts, the same thing could be done in many different ways; that the numerous guns in the American service were very differently formed at the breech, and required the *arrangements* to be varied accordingly, so as to render the invention applicable to them, and useful to the government; that so long as the principle was the same, any mere variation of form would be an invasion of my patent, especially where the change, or variation, was the consequence of necessity or convenience. He, perhaps, thought otherwise. I had also in my possession at the same time, a lock mounted on a skeleton cannon, with the vent contracted, and placed on the side of the vent field; this, if my recollection serves me, was standing in the room at the time; of this, however, I will not be certain, but it is certain that I described it, and some other modes, which I had reduced to practice. Of these facts, and the conversation which passed at the time, I have the most unimpeachable evidence.

Now as these observations involve something more than a mere statement of isolated facts, your attention to them by an insertion in the Journal of the Franklin Institute, will oblige one, at least, who has benefitted his country by the introduction of a valuable discovery,

(not a contrivance,) through years of expensive experimental labour, but whose lot it may be, like many others, to be deprived of his just reward. It is, however, to be hoped, that the time has come, when a simple change in the *arrangement* of the parts of a valuable instrument, will not entitle the speculator to a preference, and leave the original inventor destitute.

I am, sir, very respectfully,
your obedient servant,
Joshua Shaw,
Christian street, Philadelphia.

On Mr. M. Smith's *improvement in Compass Needles.*

TO THE EDITOR OF THE JOURNAL OF THE FRANKLIN INSTITUTE.

City of Washington, February 10th, 1831.

Sir,—In the remarks which you appended to the specification of my patent for an improvement on surveyors' and mariners' compass needles, published in your last volume, p. 238, allow me to say that the remarks which you make on the theory upon which I have proceeded, are liable, and likely to prejudice the minds of most of your readers against the needle itself, or the improvement which I believe that I have made in it. The greater number of persons are incapable of abstracting the theory from the fact, and are apt to think that if the former is impugned, the latter must fall with it. I really have not the arrogance to pretend to form a theory upon subjects where those who are greatly my superiors in learning are at a loss. I am a mere practical man; the earlier period of my life was spent in the service of my country, in the revolutionary war; and since that time, I have been much engaged in practical surveying. This first led me to pay particular attention to the compass needle, and to a desire to remove some of those difficulties which often baffle the surveyor and the mariner, and not unfrequently endanger the safety of the latter. I think I have now, in the eve of my life, something to offer to my country, which will be found to be a valuable practical improvement. Leaving, therefore, the discussion of the theories to others, and abandoning every thing in my specification which is merely theoretical, I will merely ask you to state to the public the facts which I have recently exhibited to you, as I think by so doing you may do an essential service to society, and perhaps benefit an humble individual.

If I have done something more than other mere practical men, it may be fairly attributed to a degree of persevering industry, which has always kept my eyes open to those facts which have come under their notice, and a disposition to endeavour to turn them to advantage.

That you are as much a friend to truth as I am, and that it is your wish to disseminate it, I am fully convinced. You will, therefore, I am sure, insert this letter in the next number of your Journal, with

such other matter as you may think calculated to place my claims in their proper light.

Very respectfully, &c.

MOSES SMITH.

Remarks by the Editor.—After receiving the foregoing letter from Mr. Smith, we should think it not only unkind, but unjust, to say any thing further respecting the theory of what he calls his electric rods; and more particularly as we are convinced, from what we have ourselves seen, that Mr. Smith has actually made one important discovery as regards the magnetic needle. It is well known that from the firing of cannon, and violent concussions of other kinds, the magnetism of the compass needle, becomes deranged, or confused, in which state it will be generally found to have several, instead of only two poles; and its directive power is consequently destroyed. In the experiments exhibited to us by Mr. Smith, he took a needle, the directive power of which was perfect; he struck it a moderate blow at each end, longitudinally, and it became deranged; on striking it transversely on each side of its centre, its power was instantaneously, and *perfectly* restored: this he repeated several times. He then placed it upon a table, held it firmly down, in the manner described in his specification, and by striking the table, produced effects analogous to those which resulted from striking the needle itself. This instantaneous mode of restoring the magnetic power, which was new to us, may, it is manifest, be of incalculable importance, particularly at sea, where the safety of all on board a vessel frequently depends upon the good order of the compass needle. Mr. Smith avers, that in all cases of accidental disturbance of the magnetic power, his method is effectual, and he appeared to be borne out by his experiments. With respect to what he calls his feeders, he believes himself justified by long continued observation, in concluding that they protect the needle from foreign attractions, and increase its directive power. They are now in a fair way of being tested, as there are some of them on board of our ships of war. Mr. Hasler, whose judgment in such cases is well known to every man of science, is very favourably impressed with regard to their operation, and has given a testimonial to that effect; and several other gentlemen conversant with this subject, anticipate much advantage from Mr. Smith's inquiries.

FRANKLIN INSTITUTE.

Monthly Meeting.

THE stated monthly meeting of the Institute was held at their Hall on Thursday evening, January 27, 1831.

Mr. ISAAC B. GARRIGUES, was appointed chairman.

The minutes of the last meeting were read and approved.

The following donations were presented to the Institute, viz.

By Mr. A. B. Hutton.

Historical and Descriptive Anecdotes of the Steam Engine, and of their inventors and improvers, by Robert Stuart.

By Mr. John Ronaldson.

Elements of Natural Philosophy, by John Leslie, Esq. Vol. 1. (*including Mechanics and Hydrostatics.*)

By the Board of Managers of the Institute, for 1830.

Observations sur la Physique, sur l'Histoire Naturelle et sur les Arts, Vol. 1 *to* 27, *and* 32 *to* 40.

By C. C. Biddle, Esq.

A series of the National Gazette and Literary Register, from November, 1820, *to June* 30, 1830.

By Mr. A. Ramage.

A medal issued on the opening of the Liverpool and Manchester Rail-road.

By James Dundas, Esq.

A medal issued on the proclamation of William IV. king of Great Britain.

By Mr. James Harper.

The Report of the Managers of the Schuylkill Navigation Company, for 1830.

The corresponding secretary laid on the table the following works, received in exchange for the Journal of the Institute, viz.

Journal of the Philadelphia College of Pharmacy, Nos. 1, 2, 3, *Vol.* 2.

The Mechanics' Magazine, and Journal of Public Internal Improvements, for December.

London Journal of Arts and Sciences, for November and December.

The Register of Arts and Journal of Patent Inventions, for November and December.

The Repertory of Patent Inventions, for November and December.

Professor A. D. Bache, from the committee on explosions of steam engines, reported that the committee were progressing in their preparations for the experiments, and expected to be engaged in trying them previous to the next meeting of the Institute.

Mr. D. H. Mason called the attention of the meeting to the subject of the method of applying the power of steam engines to locomotive carriages, when, on motion, it was resolved, that the subject be placed on the minutes for discussion at the next meeting.

On motion, it was resolved, that a committee be appointed, whose duty shall be to keep a meteorological register, which shall be published monthly in the Journal of the Institute.

Mr. Reuben Haines, Professor A. D. Bache, Messrs. W. Keating, W. R. Johnson, and James P. Espy, were appointed the committee.

Adjourned.

ISAAC B. GARRIGUES, *Chairman.*

JAMES H. BULKLEY, *Recording Secretary.*

Board of Managers.

A MEETING of the Board of Managers of the Franklin Institute, was held at the Hall of the Institute, January 24, 1831.

JAMES RONALDSON, president, in the chair.

The actuary read so much of the minutes of the annual meeting of the Institute, as related to the election of this Board, whereupon the Board went into an election for the officers of the Board for the ensuing year. Messrs. Samuel J. Robbins and Frederick Fraley, were appointed tellers, who having received the votes of the members, reported the result to the president, who declared the following gentlemen duly elected, viz.

M. D. LEWIS, *Chairman.*

SAMUEL J. ROBBINS, } *Curators.*
ISAAC HAYS, M. D. }

The president having retired from the chair, Mr. Lewis took his seat as chairman, when, on motion, it was resolved, that the bye laws which governed the former Board, be adopted for the government of this Board, until annulled.

Resolved, that the committees appointed by the former Board, to try experiments on water wheels, and to inquire into the cause of the explosion of the boilers of steam engines be continued.

An adjourned meeting of the Board of Managers, was held at the Hall of the Institute, January 27, 1831.

M. D. LEWIS, chairman.

The minutes of the last meeting were read and approved.

The chairman nominated the standing committees, in conformity to the regulations; which nomination, after adding Messrs. C. Gobrecht, James J. Rush, and W. R. Johnson to the committee on inventions, was approved by the Board as follows.

On Premiums and Exhibitions.

William H. Keating,	Frederick Fraley,
Samuel J. Robbins,	Joshua G. Harker,
James Ronaldson,	Alexander Ferguson,
M. W. Baldwin,	James H. Bulkley.

On Inventions.

Samuel V. Merrick,	Rufus Tyler,
Benjamin Reeves,	John Agnew,
Alexander D. Bache,	Mark Richards,
Isaiah Lukens,	Christian Gobrecht,
William H. Keating,	James J. Rush,
M. W. Baldwin,	W. R. Johnson.

On Publications.

Samuel V. Merrick,	Isaiah Lukens,
Isaac Hays, M. D.	M. W. Baldwin.
Alexander D. Bache,	

On Instruction.

Alexander D. Bache,
M. W. Baldwin,
Abraham Miller,
John Wiegand,
Charles H. White.

On the Cabinet of Models.

Rufus Tyler,
John Struthers,
John O'Neill,
Joseph H. Schreiner,
Thomas Scattergood.

On the Cabinet of Minerals.

Abraham Miller,
William H. Keating,
Isaiah Lukens,
Adam Ramage,
Thomas U. Walter.

On the Library.

Isaac Hays, M. D.
Samuel J. Robbins,
Frederick Fraley,
Thomas Scattergood,
Charles Toppan.

Managers of the Sinking Fund.

Samuel J. Robbins,
Samuel V. Merrick,
Frederick Fraley,
M. W. Baldwin.

Auditors.

Abraham Miller,
Isaac B. Garrigues.

The candidates proposed at the last meeting, were duly elected members of the Institute.

Several candidates for membership were proposed, and laid over till the next meeting, in conformity to the regulations.

Extract from the minutes.

MORDECAI D. LEWIS, *Chairman.*

W. HAMILTON, *Actuary.*

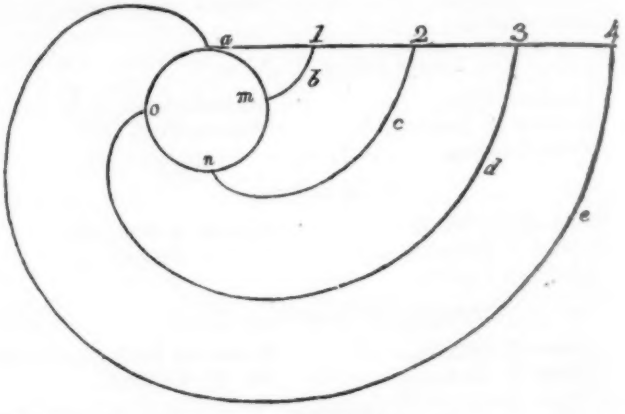
FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Remarks on the Involute.

THE curve called the involute may be formed by having a thread of any length, attached in the circumference of a circle, and stretched in a tangent to the circle, as *a*, 1, in the diagram, with a marking point at 1, which marking point is brought down to *m*, the thread being kept stretched, and winding round, and against the circle.

In a communication to this Journal, of March, 1829, on another subject, I incidentally noticed the use of this curve to express centrifugal forces. I will repeat in substance, what I then remarked, and give further examples of the practical utility of this neglected order of curves. Let the circle in the figure be the orbit of a body

revolving round an attracting centre, with a velocity that could carry it in the orbit from *a*, to *m*, in a given time; let the equal distance, *a*, to 1, on the tangential line, express that velocity. Then the curve *b*, will express the centrifugal force, or required attraction, to preserve the body in the orbit; but let the velocity be doubled, so that the body would be found in the orbit at *n*, in the same given time, then the line, *a*, 2, will express the increased projectile velocity, and the curve, *c*, the relative centrifugal force.



The line, *a*, 4, or thread, by which the curves are supposed to be made, and which represents the projectile velocity, might be indefinitely extended, so that it should be required to wind round the circle, any number of times, before the marking point should arrive in the orbit, yet the involute thus generated, would correctly express the relative centrifugal force under that velocity.

We thus see the application of this curve to express the *relative* centrifugal forces, under different projectile velocities, and before proceeding to apply it as the means of ascertaining *absolute* centrifugal forces, it is essential to state two properties of the involute, which I am not aware of having been previously known. First, that the curves generated, are to each other, as the squares of the parts of the circle, (or circumference,) on which they are generated.

Thus, if curve *b*, be equal to 1, curve *c*, will be equal to 4, curve *d*, be equal to 9, &c.

Secondly, that the involute generated on an entire circle, (as *e*,) is to that circle as the circumference of any circle is to the diameter; thus, if the circumference of the circle be 1, the curve, *e*, will be 3.1416.

Then let it be required to know the radius of a circle, in which a body revolving 60 times per minute, should have the centrifugal force equal to gravity, or, in other words, let a ball revolve on a horizontal plane, void of friction, attached to a centre by a thread, drawn by the centrifugal force in a horizontal direction. The dis-

tance from the centre of rotation to the centre of gyration in the ball, is required, which with 60 revolutions per minute, shall cause the thread to be drawn with a force equal to the weight of the ball.

We know that a constant force equal to gravity will cause the ball to describe a space, (or to fall,) equal to 16 feet 1 inch, or 193 inches in a second.

Now since the ball, by the conditions of the question, is to revolve around the entire circle in one second, and to exert a centrifugal force during that time equal to gravity, the involute generated from the entire circle, (as e,) which expresses the centrifugal force, must be considered equal to the force of gravity, or a space of 193 inches.

Then, as before stated, the involute generated on the entire circle, (as e,) is to the circumference of that circle, as the circumference of any circle is to the diameter. So will 193 inches, taken as a circumference, give a diameter of 61.4336 inches, which said 61.4336 inches is the circumference of the required circle, 19.5547 inches, being its diameter, and 9.7773 inches the radius. Let the diameter of a circle be required, on which a body revolving 30 times per minute, the centrifugal force shall equal gravity.

Then, as one revolution is performed in two seconds, and gravity will cause a body to pass through 64 feet 4 inches, or 772 inches, in that time, the involute generated on the circle, (as e,) must, in a similar manner to the last example, be considered as representing a centrifugal force equal to 772 inches, which taken as a circumference, gives 245.7346 inches for a diameter, which said 245.7346 inches is the circumference of the circle required, and 78.22 inches its diameter.

The length of any pendulum, which shall make a double vibration, that is, return to the point from whence it started, in a given time, is equal to the radius of a circle, on which a body revolving in the same given time, has the centrifugal force equal to gravity. And hence the involute has complete control of the pendulum.

For by the last example, a body revolving in 2 seconds in a circle of 78.22 inches diameter, has the centrifugal force equal to gravity. Therefore a pendulum equal to radius of that circle, or 39.11 inches, would make one double vibration in two seconds.

This is the length of the "seconds pendulum," or one, that makes a single vibration in one second.

And by the same rule, a pendulum equal to the radius of the circle in which the ball revolved in seconds, (say 9.7773 inches radius,) would make one double vibration in a second, or a single vibration in half a second.

The most simple way of tracing this connexion between the length of a pendulum and centrifugal force, is to suppose the pendulum to vibrate in the arc of a semicircle, which if twice performed, making a double vibration, would be equal to describing the whole circle, and the centrifugal force as shown by the involute, would be the same.

When the pendulum vibrates in smaller arcs of a circle, its times

are not materially affected, because the motion by gravity and the centrifugal force generated by the motion, both decrease in the same ratio.

Before closing this paper, I will add another example, embracing more points of investigation.

A double pendulum, or governor, such as is used to the steam engine, is revolving, as I ascertain by my watch, 40 times in a minute; the arms are centred in the vertical axis. I also observe, by a graduated arc, affixed to the stern, that the arms revolve at an angle of 34 degrees with the vertical axis. It is required to know the centrifugal force, as compared with gravity, the diameter of the circle in which the balls revolve, and the length of the arms from the point of suspension to the centre of the ball, (or of gyration.)

Solution.—The centrifugal force will be to gravity as sine to cosine of the angle of inclination, from the vertical axis, which determined in the usual way, is in this case as 2 to 3.

The balls revolve once in $1\frac{1}{2}$ seconds. Gravity is equal to a space of 434.25 inches in $1\frac{1}{2}$ seconds. Then I consider the involute generated on the circle as equal to said 434.25 inches, which taken as a circumference, gives 138.226 inches for a diameter, which is the circumference of a circle, where the centrifugal force would be equal to gravity; but the angle of the arms show the centrifugal force equal to only $\frac{2}{3}$ds of gravity, and as the centrifugal force, with the same number of revolutions, is as the size of the circle *directly*. The required circumference will be $\frac{2}{3}$ds of said 138.226 inches, or 92.15 inches. The diameter required 29.333 inches, and radius 14.667 inches.

The length of the arm will be the hypotenuse of the right angled triangle, whereof the radius, or 14.667 inches is the base, (also sine,) and 22 inches the height, (or cosine,) and is found by the ordinary method to be $26\frac{1}{2}$ inches, (very nearly.)

Then the answer will be as follows. The centrifugal force is equal to $\frac{2}{3}$ds gravity. The diameter of the circle is $29\frac{1}{3}$ inches. The length of the arm is $26\frac{1}{2}$ inches.

Those who have leisure and inclination for mathematical research, will find an interesting, and somewhat novel field of action presented by the involute, which curve deserves to be rescued from its present obscurity, and placed on a level with the favoured few, created from conic sections.

THOMAS BAKEWELL.

Cincinnati, December 10th, 1830.

An inquiry into the causes of the ready Souring of American Flour, and of some other faults resulting from the mode in which it is manufactured. With suggestions on the proper means of remedying these defects.

THE following communication was received from a citizen of Philadelphia, whilst on a tour in the western states. He has had

some experience on the subject upon which he writes, and we think that he has indicated the main source of the evil in question. Perhaps better plans may be devised for effecting the end proposed, but the *principle* is undoubtedly correct. [EDITOR.

Louisville, Kentucky, October 26, 1830.

TO THE EDITOR OF THE JOURNAL OF THE FRANKLIN INSTITUTE.

SIR,—Although a number of years have elapsed since it was my business to be connected with the manufacturing of wheat flour, and the bread, hard or soft, made from it; still the circumstances of flour manufactured in Richmond, Va. having acquired so *respectable* a character, both at home and abroad, while that of Pennsylvania has hardly maintained its ground, and that made in this western, or rather in this interior quarter, is remarked for not keeping well, have all concurred to recall to my mind former observations, and to elicit new ideas. Of the many manufactures carried on in the United States, the making of flour is amongst the most important. It may therefore be fairly presumed that any thing having a tendency to improve this business, in however small a degree, will be acceptable to the patrons of the Journal of the Franklin Institute, which is devoted to the improvement and extension of the useful arts, and the promotion of the industry and resources of the union.

It will be found that a mixture of different wheats, that is, red, white, bearded, and common, supposing them all of good quality, and equally well manufactured into flour, will make better bread than any one of them simply. On the miller's experience and judgment depend the best proportions of this mixture, equal quantities not being that which answers best; and as it is not at all times in the miller's power, from want of the various kinds, to preserve this proportion, his skill is called upon so to proportion what he has, as to bring out the best results.

In the next place, it is a bad system to make flour entirely out of the new crop, immediately after harvest; such flour will not keep long, and it is not profitable for the baker; it will neither produce so much bread, or bread of so good a quality as a mixture of the old with the new. Suppose, for the sake of example, that for two months after the crop of any one year comes in, it is mixed with an equal portion of the crop of the preceding year, gradually diminishing the proportion of old wheat as the season advances; flour made of this composition of new and old wheat, is certain of keeping well, will make good bread, and more of it in proportion than flour used in the same quantity but made entirely of new wheat; here too the skill of the miller governs the result.

There have been, during the last twenty-five or thirty years, many improvements in the making of wheat flour, invented and introduced into this country. I believe that we are actually, if not technically, indebted to Oliver Evans, for the "Hopper Boy," the "Elevator," and many other improvements. To lessen the expense attendant on the management of the mill, by cooling of ground wheat rapidly,

has been a primary object. But when the rapidity with which wheat passes through all its processes, and is packed into the flour barrel, is too great, it is very evident that it has not sufficient time to *cool* perfectly, and to *part with its moisture;* and it is probable this is a main cause why our flour does not keep long. It is a well known fact, that from some defect in the manufacturing, a large portion of our flour soon sours, grows hard, or otherwise spoils. This is a result most injurious to the country, and one which operates very disadvantageously on the miller, the merchant, the baker, the consumer, and the general character of the article in foreign countries.

The following new mode of managing the flour is suggested to remedy the evils just spoken of; and the writer of this is confident that all the good effects proposed, will result from the practice recommended; indeed every miller will at once see the connexion between the causes assigned, and the effect produced.

When the ground wheat issues from the mill stone, it is then quite warm, from the friction of the stones; that heat causes the latent damp that exists in wheat most sensibly to develope itself. To give the meal the greatest dryness, is to communicate to it the property of keeping long, and of readily and perfectly separating from the bran; the best mode of obtaining this dryness is now our object of inquiry.

To accomplish this all important object, it is recommended to the millers to fix an active wind fan, (fan mill,) so as to blow plenty of cool and fresh air among the warm meal just as it issues from the spout of the mill stones. This stream of air would not only cool the meal, but carry off the damp that at that moment is in its greatest state of volatility, in consequence of the heat. The stream of air would go off loaded with this vapour, but still there would remain heat, and consequently expanded moisture; a stream of air from a pair of bellows might, in addition to the former plan, be carried by a hose, and blown into the elevator; and lastly, the meal, when passing from the buckets of the elevator, might be subjected to the action of a second fan.

All this would so operate on the meal, that by the time it was converted into flour, both heat and moisture would be effectually removed; and there is every reason to conclude that flour made after this manner would keep long, and the meal would also be cool and dry when it arrived at the bolting process; it would most readily be separated into flour and bran, yielding a greater quantity of flour than by the present process.

A miller to become perfectly acquainted with the mixtures of wheat that produces the best bread, should have trials made by an intelligent, careful, and good baker. To become a good miller, this is almost essential. It is well known that when wheat flour has been ground very fine, no matter how good the quality of the wheat, and how well soever the flour may appear to the eye, the baker cannot make good bread with it. The appearance of such bread is wettish and doughy, much as when the wheat has been injured by rain in harvest time. Good judges will always prefer the flour that feels

hardish, when rubbed between the finger and thumb, as if it were fine sand, and reject that which compresses and is smooth.

Very little has hitherto been written upon the making of flour, every one acting on the knowledge he has acquired from his own experience, and with him ends all the knowledge he has acquired, with the exception of what he communicates to those immediately connected with him.

Should you think what is now communicated to you in this paper likely to do good, or to induce those of more experience to digest their ideas and observations on this subject, and give them to the public, you will publish it, as then some advantage will result from this unpretending effort to benefit the community.

Although it is well known that flour frequently sours in a short time, and occasions great loss to the merchant; and the dealers in this article, find to their cost, that the western flour is specially faulty in this respect; this is not asserted of all western flour, but only of the larger portion of what passes down the Ohio. A close inquiry into the practice of the western millers, will prove that too little attention is paid to mixing wheats, and to the using of old with new wheat. The mills are small compared with the quantities of flour they produce, and consequently it is too much hurried to have time to cool. Some of the steam mills are so constructed that the whole air in the house is loaded by the steam with more vapour than the air can hold in solution; a large portion of this is thrown into the meal, so that in such places it is certain a bad keeping flour must be made.

Yours, &c.

J. R.

On Gunpowders and Detonating Matches. *By* ANDREW URE, M. D. F. R. S. &c.

GUNPOWDER is a mechanical combination of nitre, sulphur, and charcoal; deriving the intensity of its explosiveness from the purity of its constituents, the proportion in which they are mixed, and the intimacy of the admixture.

1. *On the Nitre.*

Nitre may be readily purified, by solution in water and crystallization, from the muddy particles and foreign salts with which it is usually contaminated. In a saturated aqueous solution of nitre, boiling hot, the temperature is 340° Fahrenheit; and the relation of the salt to its solvent is in weight as three to one, by my experiments—not five to one, as MM. Bottée and Riffault have stated.* We must not, however, adopt the general language of chemists, and say that three parts of nitre are soluble in one of boiling water, since the liquid has a much higher heat and greater solvent power than this expression implies.

* Traité de l'Art de fabriquer la Poudre á Canon, p. 78.

Water at 60° dissolves only one-fourth of its weight of nitre; or, more exactly, this saturated solution contains 21 per cent. of salt. Its specific gravity is 1.1415; 100 parts in volume of the two constituents occupy now 97.91 parts. From these data we may perceive that little advantage could be gained in refining crude nitre, by making a boiling hot *saturated* solution of it; since, on cooling, the whole would concrete into a moist saline mass, consisting by weight of $2\frac{3}{4}$ parts of salt, mixed with 1 part of water holding $\frac{1}{4}$ of salt in solution, and in bulk of $1\frac{7}{8}$ of salt, with about 1 of liquid: for the specific gravity of nitre is 2.005, or very nearly the double of water. It is better, therefore, to use equal weights of saltpetre and water in making the boiling hot solution. When the filtered liquid is allowed to cool slowly, somewhat less than three-fourths of the nitre will separate in regular crystals; while the foreign salts that were present will remain with fully one-fourth of nitre in the mother liquor. On redissolving these crystals with heat, in about two-thirds of their weight of water, a solution will result, from which crystalline nitre, fit for every purpose, will concrete on cooling.

As the principal saline impurity of saltpetre is muriate of soda, (a substance scarcely more soluble in hot than in cold water,) a ready mode thence arises of separating that salt from the nitre in mother waters that contain them in nearly equal proportion. Place an iron ladle or basin, perforated with small holes, on the bottom of the boiler in which the solution is concentrating. The muriate, as it separates by the evaporation of the water, will fall down and fill the basin, and may be removed from time to time. When small nitrous needles begin to appear, the solution must be run off into the crystallizing cooler, in which moderately pure nitre will be obtained, to be refined by another similar operation.

At the Waltham Abbey gunpowder works, the nitre is rendered so pure by successive solutions and crystallizations, that it causes no opalescence in a solution of nitrate of silver. Such crystals are dried, fused in an iron pot at a temperature of from 500° to 600° Fahrenheit, and cast into moulds. The cakes are preserved in casks.

About the period of 1794 and 1795, under the pressure of the first wars of their revolution, the French chemists employed by the government contrived an expeditious, economical, and sufficiently effective mode of purifying their nitre. It must be observed that this salt, as brought to the gunpowder works in France, is in general a much cruder article than that imported into this country from India. It is extracted from the nitrous salts contained in the mortar rubbish of old buildings, especially those of the lowest and filthiest descriptions. By their former methods the French could not refine their nitre in less time than eight or ten days; and the salt was obtained in great lumps, very difficult to dry and divide: whereas the new process was so easy and so quick, that in less than twenty-four hours, at one period of pressure, the crude saltpetre was converted into a pure salt, brought to perfect dryness, and in such a state of extreme division, as to supersede the operations of grinding and sifting, whence also considerable waste was avoided.

The following is a brief outline of this method, with certain improvements, as now practised in the establishment of the *Administration des poudres et salpêtres*, in France.

The refining boiler is charged over night with 600 kilogrammes of water, and 1200 kilogrammes of saltpetre, as delivered by the *salpêtriers*. No more fire is applied than is adequate to effect the solution of this first charge of saltpetre. It may here be observed, that such an article contains several deliquescent salts, and is much more soluble than pure nitre. On the morrow morning the fire is increased, and the boiler is charged at different intervals with fresh doses of saltpetre, till the whole amounts to 3000 kilogrammes. During these additions, care is taken to stir the liquid very diligently, and to skim off the froth as it rises. When it has been for some time in ebullition, and when it may be presumed that the solution of the nitrous salts is effected, the muriate of soda is scooped out from the bottom of the boiler, and certain affusions or inspersions of cold water are made into the pot, to quicken the precipitation of that portion which the boiling motion may have kept afloat. When no more is found to fall, one kilogramme of Flanders glue, dissolved in a sufficient quantity of hot water, is poured into the boiler; the mixture is thoroughly worked together, the froth being skimmed off, with several successive inspersions of cold water, till 400 additional kilogrammes have been introduced, constituting altogether 1000 kilogrammes.

When the refining liquor affords no more froth, and is grown perfectly clear, all manipulation must cease. The fire is withdrawn, with the exception of a mere kindling, so as to maintain the temperature till the next morning at about 88° C. = 190.4° Fahrenheit.

This liquid is now transferred by hand-basins into the crystallizing reservoirs, taking care to disturb the solution as little as possible, and to leave untouched the impure matter at the bottom. The contents of the long crystallizing cisterns are stirred backwards and forwards with wooden paddles, in order to quicken the cooling, and the consequent precipitation of the nitre in minute crystals, which is raked, as soon as it falls, to the upper ends of the doubly inclined bottom of the crystallizer. It is thence removed to the washing chests or boxes. By the incessant agitation of the liquor, no large crystals of nitre can possibly form. When the temperature has fallen to within 7° or 8° Fahrenheit of the apartment, that is, after seven or eight hours, all the saltpetre that it can yield will have been obtained. By means of the double slope given to the crystallizer, the supernatant liquid is collected in the middle of the breadth, and may be easily laded out.

The saltpetre is shovelled out of the crystallizer into the washing chests, and heaped up in them so as to stand about six or seven inches above their upper edges, in order to compensate for the subsidence which it must experience in the washing process. Each of these chests being thus filled, and their bottom holes being closed with plugs, the salt is besprinkled from the rose of a watering can with successive quantities of water saturated with saltpetre, and

also with pure water, till the liquor, when allowed to run off, indicates by the hydrometer a saturated solution. The water of each sprinkling ought to remain on the salt for two or three hours; and then it may be suffered to drain off through the plug holes below for about an hour.

All the liquor of drainage from the first watering, as well as a portion of the second, is set aside, as being considerably loaded with the foreign salts of the nitre, in order to be evaporated in the sequel with the mother waters. The last portions are preserved, because they contain almost nothing but nitre, and may, therefore serve to wash another dose of that salt. It has been proved by experience, that the quantity of water employed in washing need never exceed thirty-six sprinkles in the whole, consisting of three waterings, of which the first two consist of fifteen, and the last of six pots; or, in other words, of fifteen sprinklings of water saturated with saltpetre, and twenty-one of pure water.

The saltpetre, after remaining five or six days in the washing chests, is transported into the drying reservoirs, heated by the flue of the nearest boiler; here it is stirred up from time to time with wooden shovels, to prevent its adhering to the bottom, or running into lumps, as well as to quicken the drying process. In the course of about four hours, it gets completely dry, in which state it no longer sticks to the shovel, and falls down into a soft powder by pressure in the hand. It is perfectly white and pulverulent. It is now passed through a brass sieve, to separate any small lumps or foreign particles accidentally present, and is then packed up in bags or barrels. Even in the shortest winter days, the drying basin may be twice charged, so as to dry 700 or 800 kilogrammes. By this operation, the nett produce of 3000 kilogrammes thus refined, amounts to from 1750 to 1800 kilogrammes of very pure nitre, quite ready for the manufacture of gunpowder.

The mother waters are next concentrated; but into their management it is needless to enter in this memoir.

On reviewing the above process as practised at present, it is obvious that, to meet the revolutionary crisis, its conductors must have shortened it greatly, and have been content with a brief period of drainage.

2. *On the Sulphur.*

The sulphur now imported into this country, from the volcanic districts of Sicily and Italy, for our manufactories of sulphuric acid, is much purer than the sulphur obtained by artificial heat from any variety of pyrites, and may, therefore, by simple processes, be rendered a fit constituent of the best gunpowder. As it is not my purpose here to repeat what may be found in common chemical compilations, I shall say nothing of the sublimation of sulphur; a process, moreover, much too wasteful for the gunpowder maker.

Sulphur may be most easily analyzed, even by the manufacturer himself; for I find it to be soluble in one-tenth of its weight of boiling oil of turpentine, at 316° Fahrenheit, forming a solution which

remains clear at 180°. As it cools to the atmospheric temperature, beautiful crystalline needles form, which may be washed sufficiently with cold alcohol, or even tepid water. The usual impurities of the sulphur, which are carbonate and sulphate of zinc, oxide and sulphuret of iron, sulphuret of arsenic and silica, will remain unaffected by the volatile oil; and may be separately eliminated by the curious, though such separation is of little practical importance.

Two modes of refining sulphur for the gunpowder works have been employed; the first is by fusion, the second by distillation. Since this combustible solid becomes as limpid as water at the temperature of about 230° Fahrenheit, a ready mode offers of removing at once its denser and lighter impurities, by subsidence and skimming. But I may take the liberty of observing that the French melting pot, as described in the elaborate work of MM. Bottée and Riffault, is singularly awkward, for the fire is kindled right under it, and plays on its bottom. Now a pot for subsidence ought to be *cold-set;* that is, should have its bottom part imbedded in clay or mortar for four or six inches up the side, and be exposed to the circulating flame of the fire only round its middle zone. This arrangement is adopted in many of our great chemical works, and is found to be very advantageous. With such a boiler, judiciously heated, I believe that crude sulphur might be made remarkably pure; whereas, by directing the heat against the bottom of the vessel, the crudities are tossed up and incorporated with the mass.

The sulphur of commerce occurs in three prevailing colours; lemon yellow verging on green, dark yellow, and brown yellow. As these different shades result from the different degrees of heat to which it has been exposed in its original extraction on the great scale, we may thereby judge to what point it may still be heated anew in the refinery melting. Whatever be the actual shade of the crude article, the art of the refiner consists in regulating the heat, so that after the operation it may possess a brilliant yellow hue, inclining somewhat to green.

In seeking to accomplish this purpose, the sulphur should first be sorted according to its shades; and if a greenish variety is to be purified, since this kind has been but little heated in its extraction, the fusion may be urged pretty smartly, or the fire may be kept up till every thing is melted but the uppermost layer.

Sulphur of a strong yellow tinge cannot bear so great a heat, and therefore the fire must be withdrawn whenever three-fourths of the whole mass have been melted.

Brown coloured brimstone, having been already somewhat scorched, should be heated as little as possible, and the fire may be removed as soon as one-half of the mass is fused.

Instead of melting, separately, sulphurs of different shades, we would obtain a better result, by first filling up the pot to half its capacity, with the greenish coloured, putting over this layer, one quarter volume of the deep yellow, and filling it to the brim with the brown coloured. The fire must be extinguished as soon as the yellow is fused. The pot must then be closely covered for some

time; after which the lighter impurities will be found on the surface in a black froth, which is skimmed off, and the heavier ones sink to the bottom. The sulphur itself must be left in the pot for ten or twelve hours, after which it is laded out into the crystallizing boxes or casks.

Distillation affords a more complete and very economical means of purifying sulphur, which was first introduced into the French gunpowder establishments, when their importation of the best Italian and Sicilian sulphur was obstructed by the British navy. Here the sulphur need not come over slowly in a rare vapour, and be deposited in a pulverulent form called flowers; for the only object of the refiner is to bring over the whole of the pure sulphur into his condensing chamber, and to leave all its crudities in the body of the still. Hence a strong fire is applied to elevate a denser mass of vapours, of a yellowish colour, which passing over into the condenser, are deposited in a liquid state on its bottom, whilst only a few lighter particles attach themselves to the upper and lateral surfaces. The refiner must, therefore, give to the heat in this operation, very considerable intensity; and at some height above the edge of the boiler, he should provide an inclined plane, which may let the first ebullition of the sulphur overflow in a safety recipient. The condensing chamber should be hot enough to maintain the distilled sulphur in a fluid state,—an object most readily procured by leading the pipes of several distilling pots into it; while the continuity of the operations is secured, by charging each of the stills alternately, or in succession. The heat of the recipient must be never so high as to bring the sulphur to a siropy consistence, whereby its colour is darkened.

In the *sublimation* of sulphur, a pot containing about four cwt. can be worked off only once in twenty-four hours, from the requisite moderation of its temperature, and the precaution of an inclined plane, which restores to it the accidental ebullitions. But by *distillation*, a pot containing full ten cwt. may complete one process in nine hours at most, with a very considerable saving of fuel. In the former plan of procedure, an interval must elapse between the successive charges; but in the latter, the operation must be continuous to prevent the apparatus from being cooled: in sublimation, moreover, where communication of atmospheric air to the condensing chamber is indispensable, explosive combustions of the sulphurous vapours frequently occur, with a copious production of sulphurous acid, and correspondent waste of the sulphur; disadvantages from which the distillatory process is in a great measure exempt.

I shall here give an outline of the form and dimensions of the distilling apparatus employed at Marseilles in purifying sulphur for the national gunpowder works, which was found adequate to supply the wants of Napoleon's great empire. This apparatus consists of only two still pots of cast iron, formed like the large end of an egg, each about three feet in diameter, two feet deep, and nearly half an inch thick at the bottom, but much thinner above, with a horizontal ledge four inches broad. A pot of good cast iron is capable of distilling 1000 pounds of sulphur before it is rendered unservice-

able, by the action of the brimstone on its substance, aided by a strong red heat. The pot is covered in with a sloping roof of masonry, the upper end of which abuts on the masonry of the vaulted dome of condensation. A large door is formed in the masonry, in front of the mouth of the pot, through which it is charged and cleared out; and between the roof space over the pot, and the cavity of the vault, a large passage is opened. At the back of the pot a stone step is raised to prevent the sulphur boiling over into the condenser. The vault is about ten feet wide within, and fourteen feet from the bottom up to the middle of the dome, which is perforated, and carries a chimney about twelve feet high, and twelve inches diameter within.

As the dome is exposed to the expansive force of a strong heat, and to a very considerable pressure of gases and vapours, it must possess great solidity, and is therefore bound with iron straps. Between the still and the contiguous wall of the condensing chamber, a space must be left for the circulation of air, a precaution found indispensable by experience; for the contact of the furnaces produces on the wall of the chamber such a heat as to make it crack and form crevices for the liquid sulphur to escape. The sides of the chamber are constructed of solid masonry, forty inches thick, surmounted by a brick dome, covered with a layer of stones. The floor is paved with tiles, and the walls are lined with them up to the springing of the dome; a square hole being left in one side, furnished with a strong iron door, at which the liquid sulphur is drawn off at proper intervals. In the roof of the vault are two valve holes, covered with light plates of sheet iron, which turn freely on hinges at one end, so as to give way readily to any sudden expansion from within, and thus prevent dangerous explosions.

As the chamber is an oblong square, terminating upwards in an oblong vault, it consists of a parallelopiped below, and a semi-cylinder above, having the following dimensions:—

Length of the parallelopiped, - -	$16\frac{1}{2}$ feet.
Width, - - - - - - -	$10\frac{4}{5}$
Height, - - - - - - -	$7\frac{1}{4}$
Radius of the cylinder, - - - - -	$5\frac{2}{3}$
Height or length of semi-cylinder, -	$16\frac{1}{2}$

Whenever the workman has introduced into each pot its charge of ten or twelve hundred weight of crude sulphur, he closes the charging doors carefully with their iron plates and cross bars, and lutes them tight with loam. He then kindles his fires, and makes the sulphur boil. One of his first duties, (and the least neglect in its discharge, may occasion serious accidents,) is to inspect the roof-valves, and to clean them, so that they may play freely before any expulsive force from within. By means of a cord and chain, connected with a crank attached to the valves, he can, from time to time, ascertain their state, without mounting on the roof. It is found proper to work one of the pots a certain time before fire is applied to the other. The more steadily vapours of sulphur are seen to issue from the valves, the less atmospherical air can exist in the chamber,

and therefore the less danger there is of combustion. But if the air be cold, with a sharp north wind, and if no vapours be escaping, the operator should stand on his guard, for in such circumstances a serious explosion may ensue.

As soon as both the boilers are in full work, the air is expelled, the fumes cease, and every hazard is at an end. He should bend his whole attention to cut off all communication with the atmosphere, securing simply the mobility of the valves, and a steady vigour of distillation. The conclusion of the process is ascertained by introducing his sounding rod into the pot, through a small orifice made for its passage in the wall. A new charge must now be given.

By the above process, well conducted, sulphurs are brought to the most perfect state of purity that the arts can require; while not above four parts in a hundred of the sulphur itself are consumed; the crude, incombustible residuum varying from five to eight parts, according to the nature of the raw material. But in subliming sulphur, the frequent combustions inseparable from this operation carry the loss of weight in flowers to about twenty per cent.

The process by fusion, performed at some of the public works in this country, does not afford a return at all comparable with that of the above French process, though a much better article is operated upon in England. After two meltings of *grough* sulphur, (as imported from Sicily or Italy,) eighty-four per cent. is the maximum amount obtained, the average being probably under eighty; while the product is certainly inferior in quality to that by distillation.

[*Journal of the Royal Institution.*

[TO BE CONTINUED.]

Account of the processes followed in Mexico, in the reduction of the Precious Metals. Extracted from a review of a work entitled "Commentaries on the Mining Ordinances of Spain;" contained in the Journal of the Royal Institution of Great Britain.

ONE object of the author of the above work, is to give as much instruction and useful information as he could collect, on the various subjects connected with mining and the reduction of the metallic ores; and particularly that which is of a nature to interest the practical miner and metallurgist, and to lead them to the attainment of greater perfection in their several departments.

Amongst the most interesting of the subjects discussed under this head, is that of the reduction of the ores of the precious metals; under which the author takes an opportunity to describe the processes employed for that purpose in Mexico, at the period when he wrote, and which are, with little or no variation, the same now practised in that country. The Mexicans are not so rude and unskilled in the art of reducing their ores, as they have been erroneously supposed in this country to be. The processes employed by them, although conducted with little scientific knowledge, and, generally speaking, with no other guide than long practice and experience in the pur-

suit, are found, from the nature of the ores, and the circumstances of climate and other local accidents, to be better adapted for that country than any others, as is sufficiently proved by the complete failure of Sonneschnied and his colleagues, in their attempt, under the auspices of Charles III., to introduce into America the improvements of Europe.*

The smelting process is described by the author as follows:—

"*Of preparing and mixing the ores, previous to their reduction by smelting. Of the construction of the various smelting furnaces employed.*—All the ore raised from the mines is carried to the reduction works, where a receipt is signed on the memorandum brought by the carrier from the mine. The workmen at the reduction works, taught by experience, distinguish the ores adapted for smelting, from those proper for amalgamation, according to their nature, and arrange them separately in an office or store room. The ore is pounded by beating with a pick or hammer, or more readily, and at less expense, in stamping mills; and being reduced to fragments of a greater or less size, according to its tractability or obstinacy under the action of the fire, it is piled in heaps, or spread out at once for the purpose of making the *revoltura* or *revolturon*, which is the mixing together of several ingredients, namely, the principal ore, the assistant ore,† litharge, impregnated cupels or bottoms of furnaces, *plomillos*,‡ *fierros*,§ and slag.

"In making this mixture, the nature of the ore is attended to; some ores requiring a mixture of all these ingredients, and others not. No general rule, however, can be given for these mixtures, but the miner must frame rules for his own government, founded on repeated experiments and long observation, making him familiar with the nature of the ore.

"The mixture, being prepared in the manner above described, is placed in the furnace to be smelted. There are many descriptions of furnaces; some being made of stone, some of mud bricks, and some of clay. In some the smelting is performed with wood, in others with charcoal; in some the mouths or apertures are stopped up, and in others left open. In some, the ore and wood are mingled together; in others, the wood or charcoal is not in contact with the ore, but the flame only, whence they are called *reverberatory* furnaces.

"*Of the smelting of ores.*—Having made the proper mixture, and prepared the furnaces and the machines for supplying them with wind, the smelter must heat or anneal the furnace, if, from being

* See Sonneschnied's *Tratado de la Amalgamacion de Nueva Espana;* in the preface to which the author acknowledges his inability, after ten years labour, to introduce with effect, into Mexico, either the process of Baron Born, or any other, preferable to that of the *patio*, which, he says, in p. 91, of the work, "has subsisted two centuries and a half, and will subsist as long as the world endures."

† "Metal de Ayuda"—Ore of a more fusible character, mixed with the less tractable ores to assist their fusion.

‡ "Plomillos"—Scoriæ charged with *lead*.

§ "Fierros"—Slag or scum, being an unreduced mass of oxides and sulphurets, in which those of *iron* predominate.

new or newly repaired, it requires it; for, if the ore be thrown in whilst the furnace is cold, it is apt, upon getting warm, to fly or crack, with danger to the bystanders: and if it be moist, in the summer, the same thing will happen, and it will explode with very great force. During the first few hours, charcoal is first thrown in, then a basket of slags, then one of charcoal, and so on, until it be time to add the mixed ore. Half a basketful of this is then thrown in, and upon that a basket of charcoal, and so on, until the furnace begins to work, after which, alternate basketsful of mixed ore and charcoal are thrown in. One or two *cargas* of charcoal are consumed for each charge, according to the nature of the ore; some ores requiring the furnace to be moderately filled; others, that it should be filled to the top. If the ore be not earthy, but clean, the furnace may be charged freely.

"The furnace being thus arranged and brought into play, smelts four charges in twenty-four hours, the ingots being tapped off from time to time; for which purpose, an aperture is made below the bridge of the breast pan, and the melted portions run off into the float. The first ingot let off, after repairing the furnace, is called *calentadura*, and is smaller than the others, because the furnace becomes coated with vitrified ore adhering to it, and care is therefore taken not to throw in rich ores for the *calentadura*. The fused metal being let off, the bridge is stopped up, the breast pan is cleared out, charcoal dust is thrown into and around it, and the furnace is again set to work. The portions which may have adhered to it are taken off last of all, and are mixed with the ores in future smeltings.

"After the smelting is performed, the furnace is uncharged, which is done in the following manner. The charges of ore being all finished, slags and charcoal alone are thrown in, until all the smelted ore has flowed into the breast pan, when the furnace throws off a very beautiful flame. The wall of mud bricks, and every thing which may have adhered to it, are then broken down with a crow or iron bar of about twenty-five pounds weight. And here the unfortunate smelters suffer much, during an hour of great labour; for the furnace is hot in the extreme, the crow is heavy, and the incrusted matter adheres very closely. The smoke and vapour from the slag, which are quenched by pouring water upon them, and which are consequently carried down to the feet of the workmen, are poisonous; and as they drink water incessantly to relieve their exhaustion, they lose the use of their hands and feet, and become bloated. They are subject also to violent pains in the stomach, occasioned by the coldness of the ore."

After describing the mode of refining the silver, the author proceeds to describe the operation of cold amalgamation, or amalgamation by the *patio*, by which the greater part of the gold and silver now circulating over the whole globe has been reduced from the ore.

"*Of the reduction of ores by quicksilver.*—Nature, by exhibiting to mankind the effect of fire in fusing the surface of mountains, first suggested to them the idea of smelting the ores containing lead. Nature also, by setting before them the particles of quicksilver found

amongst the ores, first guided them to the method of mixing the harsh ores with quicksilver, salt, and water; an operation which, although in the infancy of the discovery rude and troublesome in practice, requiring many months to effect the reduction of the gold and silver, has now, by the devices of art, and the lessons of experience, (the best instructer in the hidden mysteries of physics,) been carried to perfection; *magistral** and various other mixtures being employed, so that the ore may be reduced in twenty days, or under—and the process has even been completed in twenty-four hours.

"The object of first importance, in the process of amalgamation, is to provide a skilful amalgamator, capable of distinguishing between smelting ores, and those adapted for amalgamation; who can make assays, in the small way, to ascertain what the *monton* will yield in gross; who understands the proper ingredients, temperatures, admixtures, and stirrings to be applied, and who can calculate and compare the probable amount of the expenses and of the metallic produce: for the bringing the silver to the proper point is not to be entrusted to a mere ignorant blockhead.

"Secondly, a due selection of the ores must be made for the purpose, in performing the reduction by amalgamation, of making such mixtures as their nature may require; and such ores as require smelting, must be set apart for that operation.

"Third, the ore must be ground as fine as possible, that the quicksilver may combine more readily with the silver.

"Fourth, the ore being ground, it is the practice, in some districts, to roast such as is of a sulphurous or bituminous (?) nature, in furnaces adapted for that purpose; in which the criterion of being sufficiently purified, is the ceasing to give off vapour. The same treatment is also applied to the pyritous or resplendent ores, which, under the influence of fire, lose their splendour, and at the same time, get rid of their prejudicial qualities. Those which contain litharge or copperas, should not be roasted, until they have been washed and thoroughly agitated in tubs of water, so as to separate the copperas; for unless this precaution be taken, it will be increased in quantity by the action of the fire, instead of being driven off, and it will have the effect of destroying the quicksilver, and preventing its uniting with the silver. It is sometimes proper to roast the ore after grinding, and sometimes while in the rough. But the most usual course, in the mining districts of New Spain, is not to roast the ore at all, on account of the injurious effect of the operation, in rendering it dry, in diminishing its richness, and in augmenting its bad qualities.

"Fifth, the ore being ground, is thrown into heaps or *montons*, usually of 30 quintals; but in some places of 18 quintals: and the *montons* are sometimes placed beneath a roof, but most frequently in a well flagged yard or *patio*, whence this mode of reduction is called the reduction by the *patio*.

"Sixth, with each *monton* of 18 quintals, are mixed two barrels

* Sulphuret of copper, roasted and ground to powder.—*Trans.*

of brine, from impure salt; six, eight, or ten pounds of *magistral*, as the nature of the ore may require, and from ten to twelve pounds of quicksilver. The *monton* thus prepared, is stirred and trodden, which is called *repasar*. After two or three days, the stirring and treading are repeated, and if it require more quicksilver, a further charge is thrown in, and it is again stirred, until found to require no more: and it is to be observed, that the more quicksilver it requires, the better, as a proportionate quantity of silver may be expected.

"Seventh, the quicksilver must be added at different times, and not be thrown in all at once, so that it may by degrees take up the whole of the silver. The first stirrings must be performed with softness and gentleness, lest the quicksilver should become too minutely divided, and form *lis*, which is the term applied when it divides into almost imperceptible particles. From the varying nature of the ore, and the diversity of circumstances which arise, no certain rules can be laid down for the course to be pursued in stirring in the quicksilver and *magistral*, and it will therefore be found, that it is sometimes necessary to excite heat by stirring, and at others to apply moisture. Neither is it possible to determine the precise moment at which the *montons* are in a state for washing, for though they may not make any *lis* of silver, nor require any more quicksilver, yet the quicksilver may be dispersed. The only rule is, to ascertain whether the proportion of silver taken up, corresponds with the result of the assay made at the commencement of the process; and there is no way of ascertaining this, but by making a further trial, in a small way, whether the *monton* is in want of any addition, which in such case must be supplied, or whether it is complete, in which latter case the *monton* may be washed.

"Eighth, the *monton* being ready for washing, is thrown into wooden vats of very large size, within each of which is contained a mill. The mill is turned by a mule, and it is proper that it should not always go round in the same direction, but that the motion should be sometimes reversed: the object being, that the *lises* of silver may fall to the bottom, and that the quicksilver contained therein may not be lost by escaping with the slime or earthy residue, which contains a proportion of silver, and also of quicksilver in a minute state of division. To prevent this loss, it is therefore necessary that the mixture should be kept briskly stirred in every part. The slime being separated, the quicksilver remains at the bottom of the vat, combined with the silver, in which state it is called amalgam. The amalgam is taken out and placed in a linen bag, which being suspended from the beams, the uncombined quicksilver runs out. The part which remains in close combination is made up into small cakes, which are formed into one large cake or *piña*, (pine apple,) the size being adapted to the capacity of the brass cap or bell. The latter consists of two pieces, the first of which is in the form of a large basin, with a groove round the rim and a hole in the bottom. On the inner part of the rim are three rests, on which is placed a grating, made of iron bars, and upon that is set the *piña* or cake, which

is covered over with the cap. The cap is bell shaped, and fits into the groove of the vessel, which must be surrounded with earth, and have a pan of water beneath it. The cap or bell remains above, and is covered entirely with ignited charcoal, the heat from which, raising the quicksilver in vapour, it finds its way into the vessel, and passing through the hole in the bottom, is received in the pan of water, and brought back into the state of fluid quicksilver. Where caps of brass, copper, or iron, cannot be procured, they must be made of the finest clay, adapted to resist the fire.

"The proportion of silver returned, depends on the quality of the ore; sometimes the produce of silver is equal to an eighth part of the quicksilver mixed in with the *monton*, sometimes a sixth part, and sometimes a fifth part. The quicksilver separated in a liquid state, still contains minute particles of silver, and it is set apart to be used in working other *montons*, until consumed. This is the only part really consumed;* for the rest is either lost by being converted into *lis* in the *montons*, or escapes with the slime, from the agitation of the mill, being divided into the most minute and imperceptible particles. A quintal of quicksilver is not wholly consumed until after it has been employed seventeen times."

When the ore is tolerably rich, and a more speedy return of the silver is desired, another process is sometimes resorted to, which is called the *beneficio par cazo*, or reduction by the *cazo*. This process has the advantage of wasting very little quicksilver, and is thus described:—

"*Reduction by the cazo*, (*pan.*)—This method of reduction affords the most speedy means of extracting the silver. The ore being thoroughly ground, and a quintal being taken, the proper quantities of salt, water, and quicksilver, are mixed in, according to the nature of the ore. The mixture is then placed over the fire, and must be kept constantly stirred, and the act of ebullition further assists in keeping it in motion. It is tried from time to time, to ascertain whether it requires any further addition of quicksilver or salt. Each pan will reduce three charges per day. If the ore be rich it will often yield a marc, a marc and a half, or two marcs per quintal: and provided the quality be not lower than six ounces, this mode of reduction is very advantageous; but if the produce of silver be below that rate, it will not answer, from the great consumption of wood, quicksilver, and salt, together with the cost of the pans and coppers. The latter must be closely attended to, to see that there are no chinks or cracks in the bottom, through which the quicksilver might escape; to prevent which, they should be varnished with several coats of lime, slag, iron, and white of egg, well beaten up together. *Barba* expresses himself in highly approbatory terms of this method of reduction, both on account of the saving in quicksilver,

* In Mexico, the difference between the quantity of quicksilver employed in the process of reduction and the quantity recovered, is arbitrarily divided into quicksilver *consumed* and quicksilver *lost;* a quantity equal or proportionate in weight to the silver obtained, being said to be *consumed*, and the remainder of the deficient quicksilver to be *lost*.—*Trans.*

and because fuel may be supplied from various trailing plants, which abound in the Indies, and may likewise be much economised by making one furnace heat four pans, as we have seen in several sugar mills in the kingdom of Mexico.

"The assays in the small way will indicate, exactly, what quantity of silver the boiling should yield; but this is more readily ascertained by inspecting the substance itself, which, being taken out with a ladle, and the slime being separated, the metal remains. The slime is separated by washing, in vats of water, supplied from a cistern appropriated to the purpose. This operation removes all the earthy matter and slime; which, when a sufficiency is collected, are worked over in the process of reduction by cold amalgamation. The quicksilver settles, and is found at the bottom of the vat, combined with the silver. The quicksilver is then separated, in the manner described under the head of reduction, by the *patio;* but it always requires refining, never turning out pure, like that from the *patio.*"

A third method depends on the employment of sulphate of copper, or *colpa.* This process, called the *beneficio por colpa,* is as follows:—

"*Of the reduction by colpa,* (*sulphate of copper.*)—The plan or sketch of the new method of reducing the silver from all classes of ore, whether cold or warm, by means of *colpa,* or white or yellow copperas, was described by Don Lorenzo Phelipe de la Torre Barrio y Lima, a proprietor of mines in the district of San Juan de Lucanas, in Peru, and was printed at Lima, in 1738, and reprinted at Madrid, in 1743; where a summary of the discovery was likewise printed separately, in the same year, which met with commendation from the pen of Father Feyjoo.* The discovery consists in employing *colpa,* or copperas; the goodness of which is tried by reducing it to powder, moistening it with water, and throwing some globules of quicksilver into it. If the quicksilver spreads, or separates into minute particles, the *colpa* is good; and the like if the quicksilver, when placed on the *colpa,* and stirred in a cup or with the finger, assumes a bluish ash colour, or divides.

"The ore and the *colpa* being well ground, the latter is to be taken in an equal proportion to the salt used. The mixture is to be stirred, as in the ordinary process of reduction, four times a day, and is afterwards to be charged with about two quintals more of the *colpa,* and water is to be sprinkled uniformly over it. The quicksilver is then to be stirred in, in such quantity as the nature of the ore may require. After six days an assay is made, the stirring being continued; and if the ore be too warm, it is allowed to cool, or lime is thrown in; after which fresh charges of quicksilver are added from time to time. The slime must be washed without throwing in any quicksilver by way of *baño.*† When the quicksilver is driven off, it will be found that a greater proportion of silver is obtained, and that none of the quicksilver is consumed, except such part as is lost

* Cartas eruditas, tom. ii. carta 19.

† A term applied to a supplementary proportion of quicksilver, usually thrown in by way of softening the slime preparatory to washing.—*Trans.*

in the stirring, or from other accidental circumstances. This is the method pursued with the cold ores.

"For the warm ores it is said, that when ground, a basketful of lime is to be thrown uniformly over them. To twenty-five quintals of ore, ten *arrobas** of salt are to be added, with a sufficient quantity of water, and the mixture must undergo four stirrings. The next day, the *colpa*, being first well prepared, is to be added, in the proportion of one-half, to the weight of salt used; and a sufficient quantity of water being added, the mass is to be stirred four times, and as often on the following day. The mass being spread abroad, another *arroba* of *colpa* is to be thrown in, distributing it uniformly, and the mixture is to be sprinkled with water. When thus moistened, the quicksilver is to be stirred in; and three days after, it must be ascertained, as in the ordinary mode of reduction, whether the *montons* are cold and require more stirring, or whether they are warm, and demand a further addition of lime."

Other methods of reduction are likewise described, which, being in less general use, we pass over.

When on the subject of boundaries, the author describes, at some length, the method of mine surveying practised in New Spain, and the simple instruments employed for that purpose; and he takes occasion to recommend the adoption of the method then practised in Europe, which he illustrates by descriptions of the instruments, figures, and diagrams. (Vol. i. p. 327, &c.) The latter method being, in principle, though not in all its details, the same which is now pursued in the Cornish mines, it is unnecessary to refer to it more particularly.

The various machinery employed in mining and the reduction of the ores, is also described and illustrated by faithful, though rude figures. (Vol. ii. p. 189, &c.)

In another part of his work, the author discusses the expediency of opening the quicksilver mines of New Spain, and the probability of their admitting of being worked with advantage. The trade in quicksilver being monopolized by the crown of Spain, no mines of that metal were allowed to be worked, but those of *El Almaden*, in Old Spain, and Guancavelica in Peru, and hence no progress was ever made in turning to advantage the quicksilver veins of New Spain. But that there are such veins, and that they might be worked to much advantage, is evident from the following passages:—

"In stating above, that we have not met with any account of mines of quicksilver having been worked in the early times after the discovery of the kingdom of New Spain, we are to be understood as referring to the sixteenth century, the era of the conquest; but subsequent to that period, many instances may be found.

"First, some quicksilver mines were discovered in the jurisdiction of Chilapa, at sixty leagues distance from Mexico, to the southward.† Don Gonzalo Suarez de San Martin went over in August, 1676, to

* An *arroba* is 25 lbs. Spanish.—*Trans.*

† Villa Senor, Theatro, Americano, tom. i. page 178.

explore these mines, with a master smith and master bricklayer, and having set up a shed, a house, a smithy and furnaces, he had a part of the crest of the vein blasted away on the 14th of October, and commenced the works of San Mateo, San Joseph, and Santa Catalina, all contiguous. He began three adits at a greater depth; but the hardness of the ground obliged him to remove half a league farther down, where, finding fair indications of success, he drove the work of la Concepcion. Here also he found very good ore, in a matrix of white spar, and drove a work, which he called los Reyes. He then drove an adit in a cross direction, and, at the distance of 47 *varas*, cut a vein of considerable size. Several assays were made of the ores from these works, both in the large and small way. Those from San Mateo yielded, by the minute assay, 12 ounces of quicksilver per quintal, those from Concepcion 25 ounces, those from the cross cut 26 ounces.

"The second instance was during the viceroyalty of the Duke de la Conquista, who, in the year 1740, commissioned Don Philip Cayetano de Medina, an alderman of Mexico, and proprietor of the estate in which the Cerros of el Carro and el Picacho were situated, and Don Gregorio de Olloqui, an inhabitant of San Luis Potosi, to inspect some quicksilver mines in the aforesaid Cerros, which, according to Don Mathias de la Mota,* are in the jurisdiction of the Sierra de Pinos, in the kingdom of New Galicia. The result of this commission has not become known.

"The third instance is that stated above, as having occurred in respect to these very mines of el Carro and el Picacho, in the year 1745, when the working of a newly discovered mine of quicksilver was taken up by Don Fermin de Echevers, the president of Guadalaxara. On this occasion, we know from very good authority, that the vein was found to be rich, abundant, and easily worked, and equal to the supply of the whole kingdom of New Spain; and also, that upon the result of the reduction of some of the ore, conducted under the president's orders, the cost of the quicksilver amounted to no more than 22 or 23 dollars per quintal.

"The fourth instance we shall mention, occurred previously to the last, being in the year 1743, early in the viceroyalty of Count Fuenclara, by whose order doctor Pedro Malo da Villavicencio, senior judge of the royal audiency, set out for the purpose of exploring some other quicksilver mines near Temascaltepec, the ores of which had been subjected to several experiments and assays at Mexico, by Don Manuel de Villegas Puente, factor of the royal stores, who now accompanied the senior judge; but their investigations failed of any beneficial result, and it appears that nothing but urgent necessity will ever induce the government to sanction the laws permitting mines of quicksilver to be worked, like those of silver, gold, or any other metal.

"Yet, as it is evident that there are within this kingdom mines of quicksilver, which the crown might at any moment order to be

* Mota, MS. History of New Galicia, c. 62, n. fin.

worked, nothing is easier than to demonstrate the expediency of adopting the same plan here, which has succeeded so well in the famous mines of Guancavelica in Peru.* For, first, whenever the supply of quicksilver fails, as has happened times without number, either in consequence of war, of losses at sea, or of the delay attendant upon procuring it from such a distance, the reduction of the ore in the amalgamation works is brought to a stand, the revenue is thrown into arrear, the whole kingdom suffers, the working of the mines is interfered with, and trade receives a check. By setting the quicksilver mines at work, all, or most of these evils, would be remedied, facilities would be afforded for reducing the silver in an expeditious manner, and the amount of the tenths, the one per cent. and the coinage duty would be augmented."

In confirmation of the above, it may be added, that other veins of quicksilver, appearing, by the analysis of Professor Del Rio, to afford ores worth working, have recently been discovered in Mexico. Analyses of two specimens of the ore may be seen in the Philosophical Magazine for August, 1828.

Mr. Ogden's *Marine Steam Engine.*

Sir,—In an account given in a late Liverpool paper of a public dinner of engineers and others, friends to the promotion of steam power, on the 15th of September last, I observe that the health of Mr. Ogden, the consul of the United States, at Liverpool, was proposed by Mr. Vignoles, C. E. and drank with great applause, as the person who was "the first to apply the power of steam to navigation on the ocean." Not being at all aware of Mr. Ogden's claims in this respect, and perceiving that the Editor of the "Mechanics' Magazine" was one of the party who joined in this public acknowledgment of them, I take the liberty of applying to him for some information on the subject. I doubt not that there are many others equally ignorant with myself of the service which Mr. Ogden appears to have rendered to navigation, and to whom a detail of the particulars attending it will be as acceptable as to,

Sir, your obedient servant,

W. H.

Warrington, October 15, 1830.

The grounds on which Mr. Ogden is considered entitled to the honour of being the first to apply steam to navigation *on the ocean*, admit of a very satisfactory explanation. In 1810, Mr. Ogden was engaged in making some experiments with a small steam boat, and then, as we have been informed, first gave his serious attention to the subject of steam navigation. On the following year, he made a plan, and gave a drawing of an engine, to a friend, which he proposed he should adopt for a boat he was about building. Mr. Og-

* Solorz. Polit. lib. 6, cap. 2.

den's attention being diverted from this object by other business, he thought no more of it until 1813, when having again leisure, he matured the plan before alluded to, and obtained a patent for it from the government of the United States. The specification was in the following terms:—"This improvement is predicated on the fact demonstrated by Mr. Watt, that the elasticity of steam being proportionate to its density, its expansion, on being stopped off at one-fourth, one-third, or one-half, the capacity of the cylinder, will produce a power in a much greater ratio than one-fourth, one-third, or one-half of the whole, (vide Encyclopædia, American edition, art. Steam, Plate 478, Fig. 10.) I propose working steam, of whatever density, in two cylinders or other vessels, to be stopped off at any point from one-eighth to one-half. If at one-half, the instant one cylinder is half filled, its steam valve is closed, and that of the other is opened; on its piston arriving at the end of the stroke, that of the other will have performed half a one; *its* steam valve will then be closed; and that of the first again opened, as well as its opposite condensing valve; thus the motion will be regularly continued, each cylinder alternately half filled with steam," &c. &c. Mr. O. further claims as his invention, the application of the powers of the two pistons, in such a manner that they shall act simultaneously on the same axis at right angles with each other. It is plain that when one is at its minimum, the other being at its maximum, will carry it past the point, and that they will mutually tend to equalise the motion, thereby doing away the necessity of balance wheels."

In 1814, B. H. Latrobe, Esq. an engineer and architect of some celebrity in the United States, constructed the first engine on this principle; not, however, until he had combatted that principle most stoutly; insisting that, from the inequality of their motions, two cranks could never be brought to act together. Mr. Latrobe was induced, however, to try the experiment, and the result was most satisfactory.

In 1815-16, Mr. Ogden built a boat in the neighbourhood of New York, and set up on board of her an engine of two 27 inch cylinders, with a four foot stroke, shutting off the steam at one-half. With this boat he proceeded, in May, 1816, from New York to Virginia, where she was established to run between Norfolk and Richmond. During the passage they encountered a severe gale, when her performance astonished every person, and proved, most satisfactorily to Mr. Ogden's mind, the advantages of steam in any situation. In the autumn of that year, Mr. O. came to this country, and had an engine constructed by Fenton, Murray, and Wood, of Leeds. The same builders afterwards furnished another, from the same patterns, of two 33 inch cylinders, which Mr. O. put on board of a steam tug for the river Mississippi, and which we have heard him say he has frequently seen ascending that stream against a current of three miles and a half with a ship of three or four hundred tons on each side, and two smaller vessels, brigs or schooners, astern.

[*Editor Mechanics' Magazine.*

Description of the various kinds of Paper.

We have been requested to insert the following description of the various kinds of paper, which appeared in the *London Mechanics' Magazine*, for February, 1829. The article, which is understood to be very accurately drawn up, is rarely to be met with at the present time.

The water marks used by the English manufacturers are figured in the original paper, but are here omitted, as having little interest for the American manufacturer, or dealer. Ed.

It was well remarked by the great philosopher, Boyle, that "if every artist would but communicate what new observations occurred to him in the exercise of his trade, the advantages gained to philosophy would be incalculable."

Under a conviction of the extensive application of the above truth, I submit the following information (first collected, with some pains, for my own use,) for insertion in your widely circulated miscellany; and although the title of *new* will not apply to it, yet, as I am not aware of any thing of the kind having before appeared in print, I hope it will be considered sufficiently scientific, and of such general interest, as to procure for it that honour.

Paper may be divided into three distinct classes; viz. writing and drawing papers, printing papers, and wrapping or packing papers.

First, *Writing or drawing papers*—Writing papers are called either *laid* or *wove*, from the moulds on which they are made. Laid papers retain the marks of the wires in long parallel lines crossed at intervals by other lines, as shown by fig. 1, which is a mould for making laid papers. Wove papers, on the contrary, bear no impression of the wires, the mould used for making them being formed of very fine wire, woven in a manner similar to linen,—whence the derivation of the term *wove*. The appearance of a mould of this description is shown by fig. 2. Laid paper is generally of a bluish cast, which is obtained by adding smalt (the powder blue of commerce) to the pulp while in the vat. Wove paper is of two kinds,—blue wove, and yellow wove; the former of which is made by working the pulp to which smalt has been added, on a wove mould; yellow wove, on the contrary, is the pure colour of the rag, considerably heightened, however, by the process of bleaching. Drawing papers are always of the latter, and writing papers (emphatically so called, from imperial to demy) of the first named description. In describing the numerous varieties of post, copy, foolscap, and post papers, the distinguishing terms, *laid*, *yellow wove*, or *blue wove*, are always employed. But in all

Fig. 1.

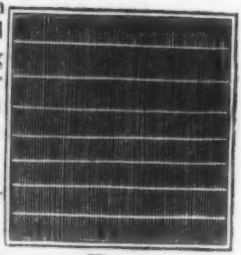
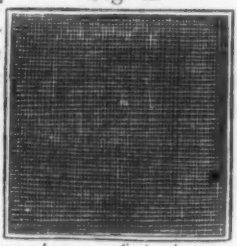


Fig. 2.



papers, from demy upwards, *wove* and *drawing*, or *laid* and *writing*, are synonymous terms; and where no distinguishing term is used, *laid* is always understood. The following is a list of the papers in this class, with their dimensions, and weight per ream:*—

Name.	*Dimensions.*		*Weight.*
	In.	In.	lbs.
Antiquarian,	52½ by	30½	236
Double Elephant,	39½	26½	140
Atlas,	33	26	100
Colombier,	34½	23	100
Elephant,	29½	21½	72
Imperial,	28	23	72
Super Royal,	27¼	19¼	52
Royal,	23½	19	44
Medium,	22½	17½	34
Demy,	19½	15½	24
Extra large thick Post,	22½	17½	25
Ditto ditto thin ditto,			18
Ditto ditto Bank ditto,			13
Ditto large thick ditto,	21	16½	22
Ditto ditto middle ditto,			19
Ditto ditto thin ditto,			16
Ditto ditto Bank ditto,			11
Extra thick ditto,	19	15¼	25
Ditto thick Post,			20
Ditto middle ditto,			17
Ditto thin ditto,			14
Ditto Bank ditto,			7
Copy,	20	16	17
Square Foolscap,	22½	18½	20
Extra thick ditto,	16½	13½	18
Foolscap,			15
Post,	15½	12½	10

Drawing papers are not made smaller than demy, and are put up into reams in the flat state. Writing papers, on the contrary, are seldom made larger than imperial, never larger than atlas, and are generally folded in half.

Considerable trouble has at different times been taken in attempting to discover the origin of the names which the several kinds of paper now bear, but without success. Another object of unsatisfac-

* A ream of paper consists of twenty quires; viz. eighteen quires of twenty-four unbroken sheets, and two quires of twenty sheets each, defective paper,—one of which is placed at the top, the other at the bottom of the ream, to preserve the inside paper from string marks, and injuries of any other kind. If the two outside quires are replaced by two perfect quires, the ream is stated to be *all insides*. A *printer's ream* consists of twenty-one and a half unbroken quires of twenty-four sheets each, and is called a *perfect ream*.

tory research, is the origin of the peculiar water marks with which each of the laid papers is distinguished.

The derivation of these marks, as well as the time at which they were first used, is mere matter of conjecture; but I am inclined to think, that on their first adoption, a closer relation existed between them and the names of the papers distinguished by them than at present. By a knowledge of these marks, the original size of any paper may be at once discovered, however much it may have been cut, or reduced in size. These remarks apply to the *laid* papers only; in *wove* papers the water marks being always omitted. The post papers are seldom retailed in the folio, *i. e.* the original size, as quoted in the foregoing list, being cut in half, and folded, and ploughed round the edges, forming quarto post, the common letter paper of the shops; this cut and again folded, &c. forms octavo post, or note paper, &c.

Having said thus much of writing paper, I next proceed to the second division of my subject,—*printing papers.* At the head of this extensive and highly useful class stand the plate papers. These papers are of the same size, weight, and quality, as the drawing papers already described,—differing from them, however, in being of a particularly soft nature,—the process of sizing, which gives the firmness so necessary in papers intended to be written on, being wholly omitted in the manufacture of plate papers. Plate paper is not made smaller than medium,—the size of the plates for a demy book. These papers are, as their name implies, used for copper-plate printing; when the plates are to be coloured, drawing paper is used, then technically called *hard plate*, in contradistinction to the former, or *soft plate.*

The following is a list of the other papers in this class, the weights and sizes of which vary greatly, according to the choice of the maker:—

Name.	*Dimensions.*		*Weight.*	
	In.	In.	lbs.	lbs.
Large News,	32	by 22	From 32 to	37
Small ditto,	28	21	23	25
Royal,	25	20	26	28
Medium,	23½	18¾	24	26
Demy,	22½	18	15	21
Short, (or Music,) Demy,	20½	14	25	28
Copy,	20¼	16¼	13	16
Crown,	20	15	7	12
Foolscap,	16½	13¼	9	14
Post,	15½	12¼	9	10½

The three last of these are generally made in the double size. Printing papers are generally of a yellow wove texture, and are not so well sized as the writing papers; but the sizing is not wholly omitted, as, without some portion of it, they would not possess sufficient strength for ordinary purposes.

I have now arrived at the third division of my subject, viz. *wrapping, or packing papers.* This class includes an almost endless variety of sorts and sizes; which, for the sake of perspicuity, I shall notice under the following heads; viz. cartridge papers—blue papers—hand papers—and brown papers.

I. *Cartridge Papers.*

Name.	*Dimensions.*		*Weight.*	
	In.	In.	lbs.	lbs.
Square Cartridge, -	33½	by 21½	From 47	to 50
Double Crown ditto, -	30	20	30	38
Elephant ditto, - -	28	23	48	52
Common size ditto, - -	26	21	40	50
Royal ditto, - -	24	19½	29	32
Demy ditto, - - -	22½	17½	26	28
Foolscap ditto, - -	16½	13¼	13	15

II. *Blue Papers.*

Name.	*Dimensions.*		*Weight.*	
	In.	In.	lbs.	lbs.
Blue Elephant, - -	28	by 23	30	
Ditto Double Crown, -	30	20	From 20	to 22
Ditto ditto Foolscap, -	26½	16	20	
Ditto ditto Royal, -	25	20	20	to 22
Ditto ditto Demy, - -	22½	18	15	18

III. *Hand (or white brown) papers.*

Name.	*Dimensions.*		*Weight.*	
	In.	In.	lbs.	lbs.
Elephant - - -	28	by 23	From 30	to 36
Thick Royal Hand -	24½	20½	36	40
Thin ditto ditto - -	24	20	16	20
Curling - - - -	23½	19½	10	12
Lumber hand - - -	22½	18½	13	15
Middle ditto - -	22	17	12	14
Small ditto - - -	20	15	6	10

IV. *Brown papers.*

Name.	*Dimensions.*		*Weight.*	
	In.	In.	lbs.	lbs.
Imperial Cap - - -	29	by 22	From 60	to 84
Bag ditto - - -	23½	19½	36	48
Kentish ditto - - -	21	17½	26	28
Small ditto - - -	20	15	11	12
Double four Pound - -	32	20	56	66
Small ditto ditto - -	28½	17½	42	52

In addition to the above, there are a variety of papers for particular purposes, which do not come under any of the divisions hitherto noticed. I therefore proceed briefly to notice the principal of them, commencing with *blotting paper*, which is well known to every person. It is made of three different sizes; viz. medium, post, and foolscap, of various colours, weights, and quantities. Blotting paper, especially the colourless description, is much used in chemical experiments, for the purpose of filtration; there is, however, a distinct kind of paper made for this purpose, and known by the name of *filtering paper;* it is generally made double crown size, of a thick woolly texture. *Tissue paper* is also too well known to need description, beyond stating that it is made the size of crown, double and single, and demy. A particular species of tissue paper is manufactured and sold under the name of *copying post;* it is wholly destitute of size, and is of a thin absorbent texture; its use is for copying newly written letters. For this purpose it is slightly moistened, and laid on the letter written with *copying ink*, and is subjected to the action of a press, kept in counting-houses for that purpose; on removing the letter from the machine, an accurate facsimile is found transferred to the copying paper, which, pasted into a book, answers all the purpose of the more tedious and laborious methods of transcribing hitherto practised. *Littress* is a kind of smooth cartridge paper, made of two sizes, royal and foolscap, and used wholly for the manufacture of cards. Among the various kinds of paper used by grocers, in addition to many of those already described, there is a thick purple paper, which forms a distinct class, under the tile of

Sugar blues, viz.—

Name.	*Dimensions.*		*Weight.*
	In.	In.	lbs.
Large Lump - - -	22½	by 32	108
Small ditto - - -	28¾	21¾	102
Single Loaf - - -	26¾	19	90
Powder ditto - -	26	18	58
Double ditto - - -	22	15¾	44

There are a species of thick brown papers, made for particular purposes; among which may be placed a large coarse paper for strong packing purposes, known by the name of *Manchester papers; sheathing paper* for ship-builders, and *tip paper* for hatters, are also of a similar description.

It is necessary here to observe, that although I have made a very marked distinction, in the mode of classification which I have adopted, between the two classes of printing and wrapping papers, yet such, in reality, does not exist; as, in some cases, the finest printing papers are applied to wrapping purposes, and many of that class (as regards size, &c.) are made of an inferior quality, for the purpose of wrapping papers,—such, for instance, as the double

crowns and demys used by grocers, hatters, &c. &c. In hand papers, again, some irregularity occurs;—elephant, which stands at the head of that class, is almost exclusively used for the manufacture of paper hangings, and is made of various qualities, according to the description of work for which it is intended. The elegant crimson and satin hangings require a paper of the best printing quality; which will not, therefore, with propriety, come under the denomination of *hand paper*. But had these and similar particulars been allowed to interfere with the arrangement I have adopted, much confusion and unnecessary repetition would inevitably have resulted. I have, therefore, given the most usual weights and sizes, which remain much the same, in whatever class the quality of the paper may chance to place it.

Coloured papers is the title of an exceedingly numerous class, which divide themselves into two kinds; viz. those which are made at the paper mill, either by colouring the pulp while in the vat, or by dying the paper afterwards; and those which are made from white papers, by persons following the business of fancy stationers and coloured paper manufacturers. Among the former class we may reckon the coloured drawing papers, for mounting, &c. crayon papers, for draftsmen; coloured printing demy, royals, &c. for the covers of books; and the beautiful tinted post and tissue papers, in such high repute with the fair sex. The second class comprises, in addition to several of the above, coloured double crowns, demys, &c. for posting-bills; coloured foolscaps,—marble, cypress, morocco, with gold and silver papers; as also papers in imitation of the various kinds of woods, tortoise-shell, &c. &c. to which I may add, a paper most beautifully executed in imitation of buhl work. Indeed, the beauty and variety of the papers in this class is such, that to be duly appreciated, they must be seen. Description, were I to attempt it, would be injustice to them.

Several papers are frequently made in the double size,—as was noticed when speaking of printing papers. The dimension of papers, in the double, may be obtained by doubling the smallest admeasurement. Thus, crown, for instance, is 20 inches by 15 inches, and double crown 30 inches by 20 inches, and so with all others.

Hoping at some future time to resume the subject, with an account of the manufacture of paper, and some of the manipulations it afterwards undergoes,

I remain, sir, yours, &c.

Wm. Baddeley, Jun.

Improvement in Watches, being an Account of a new Metallic Alloy for the Pivot Holes of Watches. By Mr. J. Bennet.

In a machine so minute and complicated, and requiring such exactness of movement, as a watch, it is evident that whatever tends to increase or overcome the friction of the different parts, deserves careful and serious attention. At no part of a watch or clock is the

quantity of friction of greater consequence than at the pivots, and the holes in which they work. The former are required to be smooth, properly proportioned, and also to be hard, to admit of being as slender as possible; and the latter should be made in such a material, as will generate the least possible friction, be hard enough to prevent the side pressure of the pivot from altering the shape of the holes, and be acted upon as little as possible by the acids, that the oil may be preserved in a pure state.

When watches were first invented, the holes in which the pivots worked were made of brass, and the plates were polished. It was found that the plates tarnished, from the action of the air, and rendered the general appearance of the watch very unsightly; and that the oil in the holes had a tendency to become impure from the action of *acids* on the brass. Gilding the plates was then resorted to, but with these disadvantages; it softens the plates, and, consequently, the holes; and the nitric acid, mercury, &c. used in gilding, has a very injurious effect on the pivots and oil. Both of these methods having their advantages, and disadvantages, it is difficult to say which is the better of the two.

Ruby, or garnet holes, were then substituted for brass holes; and, by many, these have been considered the *ne plus ultra* of this part of watch-making—a watch being considered valuable in proportion to the number of holes it has jewelled. But experience proves, that when a hardened steel pivot works in a ruby, or garnet hole, the friction may, from a variety of circumstances, be materially increased, instead of diminished by the hole. If it were possible, in *every case*, to have the two surfaces of the steel pivot and ruby hole perfectly smooth, the friction would be but trifling; but it is often very difficult to obtain this, even in the best jewelling. If there should be but the smallest imaginable part of the ruby hole unpolished, the action of that unpolished part on the pivot would be precisely the same as a common grindstone on a chisel or knife; consequently, there would be two rough surfaces rubbing each other, and, thereby, the friction would be very much increased; and ultimately the pivot, being the softer of the two, would be destroyed. The pivots which are nearest the maintaining power, and the balance staff, especially if the balance be heavy, are most affected by bad jewelling, by reason of the greater side pressure they sustain. From this cause proceeds the harsh rubbing sound of the balance staff observable in some jewelled watches. Hence, many of the most eminent watchmakers jewel only in the staff and scape wheel holes. Those who have been accustomed to repair watches with a number of holes jewelled, will have had abundant evidence of the truth of these observations. Mr. Bennett mentions two instances, out of a great number, which came under his observation, as, in them, the objection of bad jewelling, in the ordinary sense, could not be reasonably brought. He repaired, in November, 1829, a celebrated watch given to H. Brougham, Esq. M. P. by the working watchmakers of Liverpool, which is jewelled in every hole. As it is considered to be a specimen of the finest work the art of Liverpool could produce,

it is fair to suppose that they would pay particular attention to the jewelling, which certainly is very valuable, both as regards the fineness of the stones, and the beauty of the workmanship. He found that every one of the pivots were cut and threaded by the jewelling, but more especially those nearest the maintaining power; and the polished surfaces of the pivots having been worn off by the roughness of the jewel holes, the dirt, &c. which the oil had collected stained the pivots as black as ink. Now, a watch in this state, is infinitely worse than one with common brass holes, as the only remedy is to have new pivots and holes, the expense of which would be almost equal to that of a new movement; not to mention the gradual increase of friction and consequent continual change in the rate of performance of the watch. The other instance, was a very superior carriage watch, by Tregent, made for the late Duke of Kent, and now in the possession of the Duke of Sussex, in which the staff pivots were nearly cut through by the jewel holes, it having a *very heavy balance.* This illustrates a foregoing observation, that, in proportion as the side pressure the pivots sustain is greater, jewel holes tend, *above any other,* to increase the friction. A new staff was put to this watch, and the same process went on.

Watches have been made with steel holes, but these have never answered the purpose, for several reasons; principally, on account of the constant liability to attraction, between the pivot and hole from magnetic influence, the friction caused by two metals of the same kind rubbing each other, and the disposition to oxidize.

Gold has also in some cases been used, but, by reason of its softness, it is objectionable both on account of the side pressure of the pivot, and the difficulty of getting a perfectly round hole.

What appears to be wanted to obviate the objections to which the holes above mentioned are liable, is, to obtain a *metal* that shall preserve the oil in a pure fluid state, be subject as little as possible to friction, and be *softer* than the pivot, for, it is of more consequence to preserve uninjured the pivot than the hole. Mr. Bennett tried various metals both simple and compound, to procure one having these advantages:—

Platina he found objectionable on three grounds; viz.—difficulty of working;—deteriorating effect upon the oil;—and too soft to bear the side pressure of the pivots.

An alloy consisting of 3 dwt. of pure gold, 7 grains of silver, and 8 grains of steel, proved too brittle, and to possess a very coarse grain. Another alloy, prepared nearly similar to the foregoing, but having the addition of 3 dwt. 18 grains of platina, and 1 dwt. of copper, was found to have analogous properties.

A compound of 1 dwt. pure gold, 1 dwt. copper, ½ dwt. silver, and 6 grains zinc, proved very malleable, was nearly as hard as brass, and produced much less friction.

The following alloy, however, proved eminently successful; viz.—3 dwt. of pure gold, 1 dwt. 20 grains of silver, 3 dwt. 20 grains of copper, and 1 dwt. of palladium. The palladium readily united with the other metals, and the alloy fused at a temperature rather

below that required for melting gold in a separate state. It was very nearly as hard as wrought-iron, and not so brittle but that it could be drawn into wire. Its colour was a reddish brown. Its grain on breaking as fine as steel. It takes a very beautiful polish; and the friction with steel was very much less than that of brass and steel, or the previously mentioned alloy with steel. It works well. Nitric acid has no sensible effect upon this alloy. Mr. Bennett has constructed a watch, and made the holes of this metal, and it answers fully his expectations, as regards its degree of hardness, its suffering the oil to remain in a pure fluid state, and its little susceptibility of friction. It produces much less friction than the jewel hole, especially supposing the jewel not to be perfectly well polished; besides that, it will not *wear the pivot* nor be affected by the acid particles which may be contained in the oil. And with regard to expense, it has a decided advantage over the jewel hole,—as the expense of jewelling all the holes of a watch would be from £6 to £9, whereas the same number of holes may be made of this metal for as many shillings. [*Register of Arts.*

The Chemistry of the Arts, being a practical display of the Arts and Manufactures which depend on Chemical Principles, on the basis of Gray's Operative Chemist. *By* Arthur L. Porter, late Professor of Chemistry in the University of Vermont. *Carey & Lea,* 1830.

[Concluded from page 68.]

The Liming.

For this purpose take one bushel of good quicklime, and reduce it by slaking to a dry powder; introduce it into a vessel capable of containing from 60 to 80 gallons, (a common rum puncheon answers a good purpose,) and fill it with water; agitate the mixture by stirring, till it acquire the consistence of milk; lay into the bottom of the keir a stratum of cloth, having the bands of the folded piece previously made very loose, and while one man is employed in stirring the lime mixture, let another dash a bucket or two of it over the cloth, which being previously wet, absorbs the liquid very readily; let another layer be put in and wet down with the lime mixture, and so on till the operation is completed. As the mixture gets low, and of a thicker consistence in the lime cask, more water must be added till the lime is all used, and the cloth all in the keir; it is better, indeed, to add a fresh bucket of water to the mixture for every bucket that is withdrawn, till towards the very last of the lot. The manipulations in this stage of the business will be very easily comprehended when it is understood that the object is to diffuse a bushel of lime as equally as possible through a quantity of water sufficient to fill the keir to the grating, upon which the cloth rests, which will require from 300 to 400 ale gallons, and to spread this mixture evenly over the cloth. The agitation of the lime liquor must not be so violent as

to keep suspended any lumps of lime that may remain in the powder after slaking, which must be rejected at the last; for such is the activity of this agent, that it is sure to endanger the fabric where it is allowed to remain in any considerable quantity in contact with it during the boil. The cloth should be heaped a little about the vomiting pipe, so that the liquor as it falls from the pipe may subside more towards the side of the keir than it otherwise would do; much, however, depends upon the exact form of the pipe, and the violence of the ebullition; it should be the bleacher's aim to watch the boiling carefully, and adopt such little expedients from time to time as may ensure a regular and even distribution of the liquor over the surface of the cloth, and percolation through it; this is important in all the boilings, but particularly in the liming, where, owing to the very sparing solubility of the lime, an uneven distribution of the liquor may not only fail to produce the necessary effect upon some unexposed portions of the goods, but, by an unequal deposition of the solid particles of lime, produce such an accumulation upon other portions as to injure the texture. The fire may be kindled under the keir as soon as the first layer of cloth is introduced, and wetted with the lime liquor. The boiling should be kept up briskly, at least eight hours; ten hours boiling will not endanger the cloth;—it is a good rule to boil in this as well as in the subsequent buckings in potash nine hours.*

As soon as the boiling is completed, the goods may be cooled

* The whale boiler, or keir, so called, is now almost universally adopted in bleacheries, both in England and the United States. The bottom is composed of iron or copper, with a broad horizontal flanch turned up at the outer edges, to which a wooden curb is attached by bolts and nuts. This curb is usually made widest at the top; the dimensions of a curb for boiling 30 cwt. of cloth, are usually 7 feet deep, 6 feet diameter at bottom, (that is, the grate upon which the cloth rests,) and 7 feet at the top. The bottom part should have a capacity of 300 to 400 gallons. A vertical metallic tube, 5 inches diameter, and open at both ends, is firmly attached to the grate by a side flanch, and terminates below the grate within two or three inches of the bottom of the keir, and above the grate within six or eight inches of the top of the curb. This tube is generally made too small, and does not allow the liquor to pass up as freely as it should do. But the particular object of this note is to point out the advantage of reversing the form of the curb, and placing the largest diameter at bottom, and the smallest at top. The object of this change in the form is to obviate a difficulty which bleachers often experience in the common keir, that of the goods rising in the curb, and pressing up the cover, to the great loss of heat, and sometimes to the complete defeat of the boiling; for after the cloth has once risen in this way, it is very difficult to get it back again till the keir is cooled down. I have tried the change proposed with great advantage, and indeed with complete success, in obviating the difficulty mentioned.

With regard to the question, whether the employment of steam, or the direct application of fire to the keir be most advantageous, I do not consider it an important one, but prefer the latter; first, because a little higher temperature may in this way be obtained than can be conveniently obtained by steam; and, secondly, because the apparatus may be constructed at a less cost in the first instance, and maintained at less expense for repairs. I need scarcely add, that where steam is employed for this purpose, that the keirs may be constructed wholly of wood.

down by the admission of cold water, and removed from the keir. When taken from the keir the pieces are to be loosed from the band; edged up, (that is, pulled over from end to end by one selvage to shake out the folds and *crimps*,) and carried to the dash wheel. Owing to the insolubility of the lime, the washing out of this boiling requires greater attention than from any other. Some bleachers edge up and wash a second time before the potash boil; but this is unnecessary. If the dash wheel be well supplied with water, ten minutes washing is generally sufficient for any purpose; the best criterion, however, by which to judge of the amount of washing required out of either the lime or the potash boiling, is the colour of the water which runs from the dash wheel; when this ceases to be muddy, or discoloured, we may safely infer that the washing has been sufficient. From the dash wheel the pieces are thrown again into bundles, preparatory to the

First Potash Boiling.

Dissolve in an iron kettle, by heat, 100 lbs. of the best American potash, in 25 gallons of water; add to this solution while hot, 25 lbs. of fresh slaked lime, and stir the mixture half an hour; allow it to stand till the sediment subsides, and then lade off the clear liquor into another clean iron vessel. This is a standard potash ley, each gallon of which contains four pounds of potash, and should have a specific gravity of 58° Tweedale's hydrometer. Put 16¾ gallons of this solution into the boiling keir, and add water till it stand 6 to 8 inches above the grate; kindle a fire under the keir and lay in the cloth with the bands of the bundles quite loose; proceed in the boiling in all respects as in the boiling in lime, and keep up a brisk ebullition 8 or 9 hours. It is usual to put the goods into the keir in the morning, and, after boiling, to allow them to remain in it over night, and cool gradually. This will answer very well in the potash boiling; but after the boiling in lime, I should hesitate to allow the cloth to lie in the keir over night without being previously cooled down by the admission of water. In cases of great urgency, it is practicable to buck twice in twenty-four hours.

From the boiling keir the cloth is again returned to the wash wheel. It is not necessary to edge up the pieces in this washing. The liquor remaining in the keir after boiling is very dark coloured, and surcharged with the colouring matter of the cloth; it has lost in a great measure its causticity; if muriatic acid be added to a portion of this liquor, the colouring matter is precipitated of a dark greenish hue. By evaporating this residuum liquor till it acquire the consistence of thick treacle, and then exposing it to the heat of a reverberatory furnace; the vegetable matter may be burned out and dissipated, and the alkali recovered in the form of pearl ash, or the subcarbonate of potash. This was formerly practised in England, but has, I believe, now fallen into disuse. The expediency of it depends wholly on the relative value of the alkali on the one hand, and of labour and fuel on the other. Where fuel and labour are comparatively cheap, and the alkali high priced, as in Lancashire in Eng-

land, this may, in some instances, be an economical practice; but where the reverse of this is true, as in the United States, the product would scarcely reward the attempt. After washing, the cloth is allowed to drain, and is then prepared for the solution of chloride of lime.

Blanching Liquor.

The solution of the chloride of lime is known to English workmen, and, I believe, very generally to our own, by the vulgar appellation of *chemic*, a term scarcely to be tolerated in a work having the least pretensions to scientific propriety. As a popular name, however, seems almost indispensable in a treatise designed for practical men, I shall designate it by the more appropriate appellation of *blanching liquor*. It is prepared by adding 50 lbs. of the best chloride of lime, or bleaching powder, to 50 gallons of water, stirring the liquor occasionally for ten or twelve hours, and then leaving it to settle; it is most convenient to commence this process in the early part of the day, and allow the liquor to stand over night; by this means a firmer sediment is obtained, and the clear liquor is more perfectly separated from it. Add this clear solution to a sufficient quantity of water for covering the lot of cloth, (2000 lbs. as before mentioned.) The goods are to be immersed in this liquor, and particular care must be used that the bands be quite loose, and that the quantity of liquor be sufficient to cover the pieces without compressing them too hard. This solution is not so penetrating as the acid liquor, and the cisterns should have a capacity compared with the cisterns for the sours, as 4 to 3, in order that the cloth may be more fully exposed to the action of the liquid. Two thousand pounds of cloth will require for the solution of chloride of lime a capacity of about 360 cubic feet, and for the sours 270. The cloth should remain in the blanching liquor about 10 hours. It is then thrown upon a grated wooden flooring which extends about one-half the cistern, and after draining an hour or two, is ready for

The First, or Brown Sours.

Fill the cisterns for the reception of the goods to within three-fourths of their depths of the top with water, and add to it 40 lbs. of concentrated oil of vitriol, and stir the mixture well till the acid and water be thoroughly incorporated. The liquid will then have a specific gravity of $1\frac{1}{2}°$ or 2° on Tweedale's hydrometer, and a degree of acidity to the taste, about equal to that of lime or lemon juice. As the souring liquor is not often entirely changed, no very exact rule can be given for replenishing the cisterns with acid; as a general rule, however, 40 lbs. of concentrated vitriol per ton of cloth for each souring will be found sufficient. The specific gravity may be some guide, but this is liable to be influenced by other matters derived from the cloth. On the whole, the taste is the surest guide for the practical bleacher. Goods are rarely injured by too strong sours, if proper precaution be taken to prevent any parts of them from drying with the acid in them; if this precaution be neglected,

the destruction of the fabric is certain;—the reason is obvious,—if the cloth dry with the souring liquor in it, the watery parts alone evaporate, and from being impregnated with a very diluted, it becomes intimately united with a highly concentrated acid; on this account it is always better where the goods cannot be washed out of the sours, after the usual time, to allow them to remain in the liquor, in preference to leaving them long exposed to the air; or, if it be necessary to withdraw them from the liquor to make room for another lot, they should be kept wet and excluded as much as possible from the atmosphere. Damage from this source is always to be suspected where certain circumscribed spots of bleached cloths are observed to be tender, while the general texture of the fabric is sound. Ten or twelve hours immersion in the sours is sufficient, but an hour or two, more or less, is not material. After draining, return the goods to the dash wheel.

Second Potash Boiling.

The method of proceeding in this is precisely the same as in the first boiling in potash, except that only one-half the quantity of potash is used. The boiling, washing, blanching, and souring operations, are repeated in the same order and manner as already described. As the goods are, however, become more free from colouring matter, it is important that the second souring and blanching operations should be performed in separate cisterns; these cisterns are generally called by the workmen the *white chemic* and *white sours*, in contradistinction from the first liquors denominated the *brown* chemic and sours. The liquor of the brown sours should be changed after every 20 or 30 operations; but those of the other cisterns not oftener than once a year, if proper precautions be taken to preserve them from accidental impurities. Great care should be used that the cloth be thoroughly washed out of the last sours; for, if any acid remain in the cloth when dry, it certainly will be injured. In all the other washing it is usual to wash two pieces in each compartment of the dash wheel; but, in order to ensure a perfect washing out of the last sours, it is better to put only one piece in a compartment.

After the last washing the goods are passed through a trough of clear water, squeezed, and dried.

The order of the processes, then, as described in the foregoing remarks, are summarily these:—

1. Steep.
2. Wash.
3. Boil in one bushel of lime.
4. Wash and edge up.
5. Boil in 67 lbs. of potash.
6. Wash.
7. Immerse in a solution of 50 lbs. of chloride of lime.
8. Immerse in sours containing 40 lbs. of oil of vitriol.
9. Wash.
10. Boil in 33 lbs. potash.

11. Wash.
12. Immerse in the solution of chloride of lime.]
13. Sour as before.
14. Wash.
15. Rinse and squeeze.

The whole amount of materials used is one bushel of lime, 100 lbs. of potash, 50 lbs. of chloride of lime, and 40 lbs. of oil of vitriol for 2000 lbs. of cloth.

Improved gearing Chain.

An ingenious and useful construction of gearing chain for connecting cog wheels, has lately been invented by Mr. Oldham, engineer, of the Bank of Ireland, which we think highly deserving of the attention of machinists, as it is so extensively applicable to various kinds of machinery, such as carding engines; and indeed in almost every situation where a series of toothed wheels are required to be driven by one mover. It consists of a peculiarly constructed chain, with curved links, which when passed round a drum will serve as teeth, and act as a cog wheel to turn pinions, &c. and when stretched out straight, or placed on a flat surface, will form an endless rack. It may also be passed over and under a series of rollers, pinions, &c. forming a carrying chain instead of the commonly constructed chains, in which spiked wheels are employed to take into the links.

In carding engines, and various other kinds of machinery, this improved chain will work with much better effect in connexion with pinions, or wheels with common teeth, into which it is suited to gear, than the old chains, and without the possibility of slipping off, or riding over the points of spiked wheels; having a broader surface of contact: and it is not at all liable to get out of order, being much stronger than the old linked chain used with spur pinions.

Fig. 1.

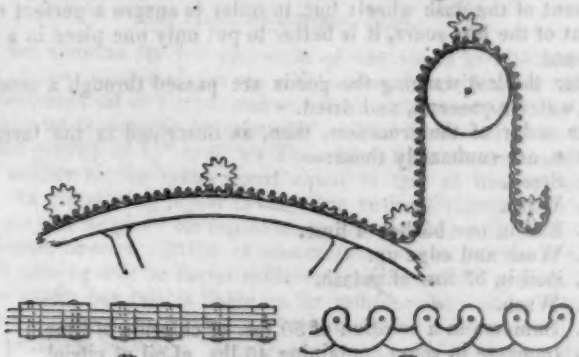


Fig. 3.

Fig. 2.

Fig. 1, is a side view of a portion of the improved chain. Fig. 2,

is a plain view of the same; it is formed by crescent shaped plates constituting links, which are connected together: one and two plates alternately, or two and three, or more placed side by side; the alternate links fitting in between each other at the joints, where they are connected by pins, or bolts passed through their eyes in lateral directions.

It will be seen that these curved links present on one surface of the chain semicircular hollows like a rack, for the teeth of the pinions to take into, and that the ends of the links, where the bolts or rivets are passed through are also formed semicircular, and the same size as the spaces or hollows of the links. These ends constitute teeth on the chain, and take into the spaces between the teeth of the pinions or wheels, and consequently drive them; or the chain itself may be driven by such pinions or wheels in the same way as a rack.

It is obvious that such a chain may be passed in various directions over wheels, on its face, and over drums at its back, and may be used with certainty of effect: as whatever motion is given to the chain, will be communicated to all that is in gear with it.

Fig. 3, shows such a chain, supposed to be endless, carried over part of the periphery of a carding cylinder, and constituting a circular rack or tooth rim, which drives all the pinions connected to it; the back of the chain is conducted over a roller, and brought into gear with other pinions or wheels; but as numerous illustrations might be produced of its applicability, it is unnecessary to say more, as its adaptation to a very wide range of machinery will at once be perceived by every practical mechanic.

Improved mode of coupling Machine Bands or Straps.

Mr. E. Budding, of Stroud, Gloucester, the recent Patentee of an ingenious machine for mowing lawns, has lately invented a new mode of uniting the ends of leather straps or bands, employed in driving machinery, which, from its simplicity and perfect security, will beyond all doubt, be adopted in every mill and manufactory where leather strapping is made use of, instead of lacing, thongs, rivets, or buckles.

In some mills where very long bands or straps are used, it is customary to secure the several pieces together by rivets, to form the whole length of strap; and to attach the two extreme ends by lacings, so as to allow of adjustment. This mode of fastening is objectionable, as the hammering of the rivet, unless very carefully done, is liable to bruise and injure the leather, and frequently causes it to break at such parts when in use; beside to make a secure joint, many rivets must be used, which is both expensive and troublesome.

Fastening straps with lacings or thongs is also objectionable, as they require many holes to be pierced through the straps, which weakens them, and when they require adjusting, a considerable time is lost in unlacing and lacing them again, to take up a hole; during

which time the machinery must stand still: and the lacings, in passing over the drums, are often cut, and very soon wear through, thus producing delay and expense, and injury to the machinery. These disadvantages are so well known to all practical men, who have the superintendence of machinery, that we feel convinced any attempt to obviate them will be acceptable to our readers.

Mr. Budding's plan consists in employing studs, or metallic buttons, the shanks or stems of which are hollow sockets, having a female screw cut in them. The stem or shank is as long as the thickness of the two pieces of strap when combined, and is made truly cylindrical, fitting the holes punched in the straps at the proper places of union. When the holes in the ends of the strap are brought together, the socket or shank of the stud is introduced through them, with the button or disk on the underside, and a screw with a large flat head is screwed tightly into the socket of the button, which compresses the leather between the button, and the screw head, as it becomes tightened up, and keeps the two pieces in close contact, producing a tight and secure joint; the strap being as pliable at the junction as at any other part.

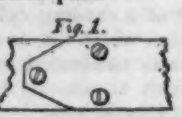


Fig. 1, is a view of the two pieces of strap fastened together, as seen on the upperside; Fig. 2, is an edge view of the same; Fig. 3, is a representation of the button or disk with its socket, rim, and the top screw, separated from each other; Fig. 4, a representation of them when put together.

When two pieces of strap are to be united, it is only necessary to punch the holes of the proper size, to suit the stem of the button intended to be used, and on bringing them together, the socket is to be introduced through them, and then the large headed screw introduced into the socket and screwed tight up.

It is obvious that this operation will take but little time, and a strap can be unfastened and a hole let out, or taken up and fastened again in a few seconds.

Straps of considerable strength and thickness, will require different sized buttons and stems, according to the rate at which they are intended to work. They are generally used three together for securing one junction of the straps, for all ordinary purposes of machinery; but for a steam engine strap perhaps five may be required: more than five is seldom necessary, unless to an engine of very great power.

The operation of attaching the straps by these studs is greatly facilitated by the use of a punch of a rather novel construction, likewise invented by Mr. Budding, the form of which is shown in Fig. 5. It consists of a clamp *a*, through which is passed the thumb screw *b*, on the lower end of which is the punch *c*. When the straps are adjusted, they are held between the clamp as at *d*, and the

thumb screws turned round, when the punch will cut a perfectly clean hole through both straps at once.

On the band of the clamp is the concave piece of steel *e*, which is file cut on its surface; when the socket of the button has been introduced into the hole, this concave piece is placed against the button, at the underside of the strap, and held in contact with it, while the screw is driven up tight, the rough file cut surface preventing the button from slipping round. Different sized punches may be fitted to the thumb screw or clamp, to suit the sockets of the different sized buttons, some of which are made small enough to connect the leather straps of carriage harness, and it would be very advantageous if stage coachmen and guards were to carry a few of these buttons in their waistcoat pockets, in case of accident,

These studs are sold from 3*s.* to 4*s.* 6*d.* per dozen, according to the size.

First Steam Communication with India.

[From the United Service Journal.]

It has for some time been a favourite object of sir John Malcolm, governor of Bombay, to establish a steam conveyance for despatches between that place and England, *via* the Red Sea, Suez, and Alexandria. A vessel called the *Hugh Lindsay*, of 400 tons burthen, with two engines of eighty horse power each, was accordingly built for this purpose, at an expense of at least 40,000*l.* Though constructed upon such a costly scale, yet the unaccountable blunder was committed, of her not having capacity to carry more than six days' coal; when it is impossible she could reach the Arabian coast from India in less than eight or ten days. If every thing, however, had been properly managed, the mails might have reached Alexandria in twenty-three days; from thence to Malta would have occupied four days more; thence to Marseilles four days; thence to England five days: total from Bombay to London, under favourable circumstances, only thirty-six days! As it was, the *Hugh Lindsay*, commanded by Captain Wilson, sailed from Bombay, and reached Suez in thirty-three days, having lost twelve days in the ports of Aden, Mocha, Judda, and Cosseir, being detained in getting supplies of coal on board at those places. The letters sent by this vessel, after all, reached England in less time than any were ever received before from India. Col. Campbell was the only passenger by her, probably from want of room, as the cabin and every other place was occupied by the coal. She was so deep in the water on leaving Bombay, that she was *à fleur d'eau*, and her wheels could hardly revolve. The distances between the several places on her route are as follow:—

From Bombay to Aden,	1710 miles.
Aden to Mocha,	146
Mocha to Judda,	556
Judda to Cosseir,	430
Cosseir to Suez,	261
	3103

which, at twenty days' navigation, would give 155 miles a day, or six miles and a fraction per hour. The despatches by steam, therefore, ought to go from Bombay to Cosseir in fifteen days; from thence to Alexandria by a dromedary *direct*, without stopping at Grand Cairo, seven days; Alexandria to Malta four days, and so on as before mentioned, making in all from Bombay to England thirty-six days; or allowing for casualties, the mails might fairly be considered due in forty days.

We have been favoured with an inspection of the following letter from an officer belonging to the *Hugh Lindsay*, detailing the operations of that vessel in this first attempt to establish a steam conveyance upon that sea, where the Lord opened a path for the Israelites of old, and where the proud Pharaoh and all his host so miserably perished. Surely, no subject can be more generally interesting, not only to the people of Great Britain, but to every nation of Europe:—

"Sir,—I have much pleasure in acquainting you with the arrival of the *Hugh Lindsay* at Suez, this day, from Bombay, which place she left on the 20th of March. The passage has occupied more time than was expected, owing to the delay occasioned by receiving coal at Aden and Judda. At the former place we were detained *six* days, and at Judda *five*. We also touched at Mocha, which detained us a day. The present trip being an experiment, I was instructed, if time permitted, to visit you at Alexandria, for the purpose of communicating with you on the subject of steam navigation in the Red Sea; but the season being now so far advanced, it is necessary we should use the utmost despatch to ensure our return to Bombay, previous to the setting in of the southwest monsoon, for which reason we shall leave Suez as soon as we have received what coal there is. We touch at Cosseir to take what fuel is there also, and we are apprehensive we shall find scarcely enough on the Red Sea to take us to Bombay.

"The *Hugh Lindsay* is 411 tons burthen, and has two 80 horse engines. By the builder's plan, she appears to have been intended to carry about six days' coal; but, in order to make the passage from Bombay to Aden, she was laden as deep as could be, and left with her transom in the water. Notwithstanding, on our arrival at Aden, after a passage of eleven days, we had only about six hours' coal remaining; which circumstance alone shows her unfit for the performance of the passage. Her being so deep, too, materially affected her speed. I met with greater detention in getting off coal at Aden and Judda than I had anticipated. Arrangements might be made

to expedite the shipment of coal at those places, but I am now of opinion the fewer depots the better, and that if steamers were built of a class that would be propelled by engines whose consumption would not exceed nine tons of coal in the twenty-four hours, and which should carry conveniently fifteen days' coal at that rate of consumption, then the navigation of the Red Sea would be best carried on in two stages, one from Bombay to Aden, and from thence to Cosseir or Suez direct. I think, too, there is no necessity for proceeding up so far as Suez, as every object might be equally well attained by going to Cosseir only. As far as the passengers are concerned, the majority I should suppose would prefer being landed at that place, for the purpose of viewing the antiquities on the route from thence to Alexandria, and the arrival of despatches would be very little delayed, when we take into account the time occupied by a steamer, on going from the parallel of Cosseir to Suez, which, when northwest winds prevail, could not be done in less than two days and a half.

"I enclose a copy of the log of the *Hugh Lindsay*, from Bombay to Suez, conceiving it might possess some interest, as the journal of the first steam vessel which has ever navigated the Red Sea.

"I am, sir, &c.

"*Hon. Company's Armed Steamer, Hugh Lindsay, Suez, April* 22, 1830."

On the Resistance of Lead to Pressure, and on the Influence of a small Quantity of Oxide upon its Hardness.

The recent experiments of Mr. Bevan on the compression of lead,* and his proposal of applying balls of that metal to estimate the force of presses, screws, &c. must be well known to English readers. A similar investigation has been entered into by M. Coriolis, which, however, is much more refined as regards those circumstances that enable the lead to resist the force applied.

The points at first under investigation by the latter philosopher were temperature, time, impact, and state of the surfaces between which the lead was confined. The pieces of lead were cylinders 24 millimetres in diameter, and 19 in height; weighing each from 100 to 101 grammes. The arbitrary scale of measurement used gave 680 divisions for the 19 millimetres of height. The lead was pressed between two plates of iron in a kind of box, allowing lateral enlargement as the pressure was exerted, and the measurements of thickness were taken by means rendering the estimation very delicate.

To remove any irregularity resulting from differences in the times of pressure, it was in all ordinary cases limited to an exact minute. To ascertain the effect of impact, two pièces, which had been pressed

* Quarterly Journal of Science, N. S. vol. vi. p. 392.

equally, were then re-pressed, the one for two minutes, the other also for two minutes, but at eight different operations. On making thus the effect of impact eight times as much in one case as in the other, still the whole difference was only 19 divisions, which, divided amongst the extra 7 impacts, gives only about 3 divisions for each. As to the original temperature, its effect amounts to little or nothing; for when the cylinders were purposely cooled down, the mere effect of compression evolved so much heat that they could scarcely be touched, and this heat soon overpowered the original difference: experimentally no sensible difference was produced. In reference to the influence exerted by the state of the surfaces between which the lead was pressed, this also proved to be insensible.

In the experiments the results are always expressed by the number of divisions to which the thickness of the lead has been reduced from the original standard thickness of 680 parts; and in this abstract we shall only give the mean results. Under the following pressures the ordinary lead used in mints was reduced to the expressed thickness.

Kilogrammes - -	1500	1824	1950	3175
Thickness - - -	463	336	337	296

When this lead was re-fused and cast, it was found to have increased so much in hardness, as with 1500 kilogrammes to give 490 degrees.

Lead was then reduced from the carbonate, and tried after being fused and cast once, twice, thrice, &c. care being taken as much as possible to prevent oxidation by the use of tallow, charcoal, &c. upon the surface. By the pressure of 1950 kilogrammes it was, after the first fusion, reduced to 333 degrees; after the second to 351; after the third, to 398, always setting off from the standard thickness of 680.

This effect was referred to a small quantity of oxide introduced into the lead at each time of pouring. To ascertain the truth of this opinion, a stopcock was attached to the bottom of the melting vessel so that the lead could be drawn off without any contact with the atmosphere, the surface above being covered all the time with a thick layer of charcoal powder. Then the former experiments being repeated, it was found that lead, after the first fusion, was reduced to 303, less than on any former occasion; after a second, to 311; and, after a third, to 301; so that now no repetition of fusion produced any effect. Some of the lead was also cast in this way, being first raised to a cherry-red heat, and others only to the lowest point necessary for liquefaction. The effects were the same in both; no influence had been exerted over the hardness of the metal, and the changes which usually occur are due to a little oxide introduced.

In experiments upon the influence of time it was found that, after a minute had elapsed, the effect of time was masked by the general effect of the metal, and nearly hidden. For a charge of 1950 kilogrammes the compressions were as follows:—

Time -	30″	45″	60″	75″	90″	120″
Thickness	365	331	322	321	319	313

So that here, after a minute, 10″ produced an effect of only 2 degrees upon the scale. Still it was found the effect did proceed; for with a charge of 1760 kilogrammes the effect was as follows:—

Time - - -	1 minute	1 hour	24 hours
Thickness	317	245	223

So that after 24 hours, the lead still continued to give way.

The most important conclusion from these experiments is, that lead fused and cast in the open air is of variable hardness, and that to obtain it with its true and constant power of resistance, it must be cast out of contact with the air, and drawn off from the bottom of the mass.* [*Journal of the Royal Institution.*

Resistance opposed to Water moving in Pipes.—(D'Aubuisson.)

Notwithstanding the endeavours made to deduce formulæ from experiments on the passage of water through tubes, so as to assist and guide the engineer in laying down pipes to supply manufactories or towns, yet frequent mistakes have occurred: thus at Paris, at the Fontaine des Innocens, only two-thirds of the water calculated upon were obtained; whilst, in the faubourg St. Victor, only the half of that expected issued from the pipes. These differences appear to result from experiments made on too small a scale, or with apertures disproportionate to the areas of the tubes; for the results of practice come sufficiently near to the formulæ of MM. Prony and Eytelwein, when the velocity of motion in a pipe was small in consequence of a contracted aperture made in a plate of metal being used. When the contracting plate was altogether removed, then the product in water was a fourth or third less than that given by the formulæ, from which M. D'Aubuisson concludes that the resistance increases with the velocity in a greater ratio than that given to it in the calculations; where it is supposed to increase proportionably as $v^2 + m\,v$, m being nearly equal to 0.055, and v representing the mean velocity.

In consequence of the arrangement and state of the water-pipes at Toulouse, some large and accurate experiments have been made there by MM. Castel and D'Aubuisson, the systems of pipes of 4.7 inches and 10.63 inches in diameter, and 1434 and 1986 feet in length. In these experiments the quantity of water passed and the pressure were varied; the results were noted, and also calculated by the formulæ, so as to deduce the loss of pressure due to the resistance of the pipes: that by calculation came out 27., 25., 32.7, and 31.7 per cent. below the result of experiment. As the two latter were the principal experiments, it is concluded that, generally, calculation gives the resistance nearly one-third less than what is obtained by actual and careful practice.† [*Ibid.*

* Annales de Chimie, xliv. p. 103. † Ibid. xliii. p. 224.

To our Readers.

We place upon the last page of the Journal, a meteorological table, for the month of January.

The Institute have made arrangements by which a similar report will be secured to our readers monthly, and a committee has been appointed charged with this object.

Particulars in relation to the locality of the observations, to the instruments used, &c. will appear in our next number.

COMMITTEE ON PUBLICATIONS.

Meteorological observations for January, 1831.

Moon.	Days.	Therm. Sun rise.	Therm. 2 P.M	Barometer. Sun rise.	Barometer. 2, P.M.	Wind. Direction.	Wind. Force.	Water fallen in rain and snow.	State of the weather, and Remarks.
				Inches	Inches.			Inches.	
	1	33°	36°	29.70	29.80	West.	Blustering.		Clear. Cloudy.
	2	28	38	30.10	30.20	do.	Moderate.		Clear. Clear.
	3	27	46	.20	.20	W. S.	do.		Clear. Cloudy.
	4	51	59	29.70	29.70	S. S. E.	do.	.90	Cloudy. Rain.
☾	5	57	42	.70	.70	S. W.	Lighter.	1.00	Rain. Rain.
	6	26	34	30.10	30.12	West.	do.		Clear. Clear.
	7	20	41	.10	.12	do.	do.		Clear. Clear.
	8	32	40	.13	.9	N. E.	do.		Cl'dy—cl'dy—hail at night.
	9	30	31	29.85	29.85	do.	do.	.65	Sleet. Snow.
	10	24	27	.75	.75	do.	do.	.50	Snow. Snow.
	11	23	32	.90	.85	do.	do.		Snow. Drizzle.
	12	26	26	.85	30.00	W. N. W.	do.		Clear. Clear.
⊗	13	8	16	30.03	.35	West.	do.		Clear—clear—very cold.
	14	20	20	.20	.10	N. E. S.	do.		Cl'dy—cl'dy—rain in night.
	15	20	23	29.33	29.30	N. E.'	High.	.85	Snow—much drifted.
	16	18	24	.40	.40	West. E.	Blustering.	.45	Snow cont'd—18 in. deep.
	17	20	20	.40	.70	do.	Moderate.		Flying cl'ds—sun. *obstr'd.*
	18	8	24	.70	.60	do.	do.		Cl'dy—cl'dy—slight snow.
	19	21	32	.60	.53	do.	do.		Clear—good sleighing.
	20	23	30	.50	.50	S. W.	do.		Clear. Cloudy.
☽	21	14	20	.80	.80	S. E.	do.	.24	Clear—cloudy—snow 2 in.
	22	11	26	.40	.40	West.	Blustering.		Cl'dy—clear—fine sleighing.
	23	10	16	.60	.60	do.	do.		Clear day.
	24	7	20	.75	.75	do.	Calm.		Cloudy—clear—*Del. ware*
	25	0	14	.70	70	do.	Moderate.		Clear day. [*frozen.*
	26	6	24	.70	.70	do.	do.		Do.
♈	27	14	26	.70	.73	do.	do.		Do.
	28	16	30	30.00	30.00	do.	do.		Do. Cloudy.
	29	24	34	29.90	29.80	do.	do.	.60	Cloudy—slight snow.
	30	18	26	.87	.90	do.	do.		Clear. Clear.
	31	12	32	.90	.83	W. South.	do.		Cloudy Cloudy.
				mdn't	.23			.90	Snow, hail, and rain in night.
	Mean	21	1 29 6	29.48	29.48			6.09	

	Thermometer.		Barometer.	
Maximum height during the month,	59.	on the 4th,	30.70	on the 2nd.
Minimum do.	0.	on the 25th,	29.30	on the 15th.
Mean do.	25.3		29.48	

Water fallen in snow and rain, 6.09 inches.

JOURNAL

OF THE

FRANKLIN INSTITUTE

OF THE

State of Pennsylvania,

DEVOTED TO THE

MECHANIC ARTS, MANUFACTURES, GENERAL SCIENCE,

AND THE RECORDING OF

AMERICAN AND OTHER PATENTED INVENTIONS.

MARCH, 1831.

Report of the Committee of the Franklin Institute of Pennsylvania, appointed May, 1829, to ascertain by experiment the value of Water as a Moving Power.

The importance of accurate knowledge in relation to the effect of water as a moving power, and the defective state of information upon that subject, induced the Franklin Institute, in the spring of 1829, to determine that a series of experiments should be made, under its direction, upon the force of water applied by wheels; the experiments to be in detail, and upon a scale calculated to give confidence in the practical nature of their results. A call was to be made upon the members, and upon that portion of the public interested in the proposed researches, for aid, to enable the Institute to effect the object in view.

To obtain this aid, and execute the necessary experiments, a committee was appointed, consisting of members of the Institute. The number originally selected, was twelve; to these two members have since been added, the committee being now composed of fourteen members.

The appeal of the Institute to the liberality of its patrons, was readily answered, and the subscription lists of the committee soon contained an amount subscribed, sufficient to warrant them in preparing for the experimental part of their labours.

There is perhaps no subject connected with the extensive branch of mechanics, for which theory has done so little, as for that which

considers the effect of water upon wheels; the different theories* advanced are at variance with each other, and with practice, so that the candid theorist confesses that the circumstances, attending the action, are of so complicated a nature as to baffle his powers of investigation. Experiment, then, can alone guide to results worthy of confidence.

The experimental inquiries in relation to water-wheels which have, deservedly, attracted most attention, are those of Smeaton.† The means of a single individual could not be competent to prosecute such a subject upon the scale required to make the results entirely practical, and we find the ingenuity of Smeaton labouring against the difficulties incident to the contracted dimensions of the apparatus which he was obliged to employ, and arranging with great skill and resource the best means to render serviceable the working models which were used in his experiments.

The experiments of Bossut,‡ which rank next in extent to those of Smeaton, were comparatively few, and were principally made upon the undershot wheel.

It would not be profitable to enumerate the isolated experiments made in different countries upon this subject, since the sum of the information which they convey is extremely small. Of late years this branch of inquiry has been but little prosecuted, and the committee are not aware that any experiments, except a few in France,§ having in view a particular form of wheel, have been made, which tend to throw light upon the subject of their labours.

Such was the progress made in this subject when the Institute undertook it, with a view to obtain such results as should afford to the millwright a sure and safe guide in his practice, and thus contribute essentially to the promotion of one of the most important of the Mechanic Arts.

After frequent consultations of the committee, a plan of experiment was determined upon: the preparations of apparatus for executing this, occupied the autumn and part of the winter of 1829, and in the spring of 1830, the experiments were commenced. These occupied the committee until late in the following December, when the operations were finished for the season.

The committee consider that so little remains to be done to complete the proposed series of experiments, that they would not be justified in delaying their report, and that the results obtained should at once be placed before those to whose liberality the community are indebted for the opportunity of information upon this interesting subject.

It is hoped that means will not be withheld, by those who have

* Young's Analysis, or Gregory's Mechanics, vol. i. and 3d vol. American Philosophical Transactions.

† Smeaton's Experimental Inquiries, &c. (Taylor's Collection, 1794.)

‡ Détermination Générale de l'effet des roues mûes par le choc de l'eau, &c. 1769.

§ Poncelet, Mémoire sur la roue Hydraulique verticale à aubes courbes. Ann. de Chim. et Phys. (1825.)

not already contributed, to fill up the last subject upon the list of inquiries.

One of the most important questions which arose for the discussion of the committee, was the measure of power expended, and of effect produced, to be adopted in their investigations. They finally determined upon one which, while strictly correct in principle, was at the same time, from its simplicity and ease of application, well adapted to their purposes, viz. for the measure of the power applied, the weight of water expended multiplied by the height of the head, (kept invariable,) above the bottom of the wheel; and for that of the effect, the weight raised multiplied by the distance through which it was raised. In order that this measure of effect may be accurate, the friction and inertia of the machine must be considered. The friction was carefully ascertained by experiment and the proper allowance made for it, as will appear in the course of this report. Any resistance from inertia was avoided by causing the wheel, and of course the weight raised by it, to move, before beginning an experiment, with a velocity which would remain constant during its progress.

The committee were very favourably circumstanced in relation to the power to be applied in their experiments, having, by the vote of the city councils, at command, a head of water fully equal to that which it was deemed necessary to employ. The greatest head used in any experiment was twenty-three feet.

The building to contain the apparatus, was erected upon a site, put at the disposal of the committee by Messrs. Rush and Muhlenburgh, which was of sufficient extent to enable them to make, to the best advantage, the various arrangements required by the undertaking.

In order that the experiments may be more easily understood, the committee preface the detailed account of them, by a general description of the apparatus used, and of the methods of experimenting. This description is accompanied by three plates, of which plates I. and II. represent side views, and Plate III. gives an end view of the apparatus employed. The drawings refer to the arrangements made for experiment with the largest wheel used, that of twenty feet in diameter; alterations were made, from time to time, to adapt the apparatus to the use of the smaller wheels. The principal parts are designated by the capital letters, the subordinate parts by the small letters.* When any of the less important parts are shown much in detail in one of the plates, they are not always exhibited on the others. A scale to which the drawings were made is attached to the first plate.

The principal parts of the apparatus were, the forebay, or reservoir, for containing the water to turn the wheel, the frame supporting the wheel, the reservoir in which was collected and measured

* There are two kinds of small letters used, the *Italic* and the Roman, the small *Italic* letters are used until the whole number is exhausted, when recourse is had to the small Roman letters.

the water used, the wheel, and the means by which the weight raised and the space through which it was raised were measured.

These will be described in the order in which they have just been mentioned.

The Forebay.

The forebay, A, B, C, D, E, F, (Plates I. and II.) was constructed of timber frame work, consisting of upright posts secured at the bottom and top by being tenanted into cross-sills and caps: the cross-sills were raised about seven feet from the ground, being supported by vertical posts, (as shown in the drawing,) resting on timbers placed upon the ground. The frame, above described, was lined with planks, and was secured from yielding to the pressure of the water at points between the cross-sills and caps, by strong iron bolts which passed through each pair of posts, on the opposite sides of the forebay, and were placed at intervals increasing as the distance from the top of the forebay diminished. The planking on the back end of the forebay was supported at the middle of its breadth by an upright post, B, C, secured by bolts to the adjacent cross-sill and cap, and, at proper intervals between them, to cross-timbers, H, H′, &c. (Plate I.) within the forebay, and supported by the planking of the sides. The floor of the forebay was laid upon the cross-sills into which the uprights of the frame work tenanted. The front end, A, F, (Plates I. and II.) projected beyond the centre of the wheel, and had, within, a breast, K, K′, K″, K‴, (Plate I.) made to fit accurately the periphery of the wheel, except near the top, (from K to K′,) where an interval was left between the breast and wheel, to facilitate the discharge of air from the buckets. The breast was secured from springing, and made moveable at pleasure, to adapt it to the use of the smaller wheels, by accurately fitting the planks composing it to circular cleats, (not shown in the figures,) spiked to the forebay on the concave side of the breast; to press the planks against these cleats, a second set was spiked to the forebay on the convex side of the breast, between which and the breast-planks wedges of the proper form were tightly driven.

In the breast, apertures closed by gates were provided at different points, through which to let the water upon the wheel. The sluices, or chutes, connected with the apertures, were narrowest at the parts where the water issued, and delivered the water to the buckets nearly in the directions of tangents to the wheel at the several points of emission. The lowest, or undershot aperture, was not in the breast, but in a vertical partition, *a*, *a*′, (Plate I.) extending from the floor of the forebay to the breast, the bottom of the aperture being on a level with the lowest point of the wheel; this aperture was closed by a gate sliding in vertical grooves, and the water flowing through it was delivered by a sluice, narrowing towards the point of emission, in a tangential direction to the lowest point of the wheel. The overshot gate at K, discharged the water immediately over the centre of the wheel. The details of drawing and description in relation to the construction of the gates and apertures, to the methods of gaug-

ing, &c. will be given when the committee treat of the action of the wheel under the several circumstances of experiment.

Water was admitted to the forebay through two iron pipes, L, L′, and M, M′, (Plates I. and II.) of 6 inches in diameter, passing through the bottom of the forebay, and connected with the pipes from the city water works: the supply was regulated by two stop cocks, at *b* and *b′*, (Plate I.) acted upon by levers of the second order, having their fulcra at *c*, and *c′*, which by the intervention of two vertical rods, *d*, *d′*, and *e*, *e′*, were connected with the levers, *d′*, *g*, and *e′*, *g′*; the common fulcrum of the levers, *d′*, *g*, and *e′*, *g′*, was at *f*, and their handles, *g* and *g′*, near the end of the forebay, were conveniently placed in relation to an assistant, on the upper floor, G, G′, whose duty it was to regulate the supply of water. The upper ends of the water pipes were made to project 18 inches above the floor of the forebay, that the rush of water from them might not produce irregularity in the action of the undershot aperture.

To show the level of the water within the forebay, a float, *h*, (Plate I.) moving freely in vertical guides, was placed at the back end: to this float a graduated tape line, *h*, *h′*, *h″*, was attached, passing over a pulley, *h′*, and kept tight by means of a weight, *h″*; an index, *i*, served to show upon the tape line the head of water sought. A valve, *k*, (Plate II.) in the bottom of the forebay, could be opened by depressing the end, *k″*, (Plates I. and II.) of the lever *k′*, *k″*, and served to allow the escape, when required, of the water, through the trunk, I, to the waste trough.

The levers for opening and closing the various gates in the breast were attached to the top of the forebay, in such positions as best to answer the ends to be accomplished by them. As the drawing would be much confused by an attempt to represent all these levers, but one system is shown, namely, that *l*, *l′*, *l″*, K, (Plate I.) for opening the overshot gate; the lever, *l*, *l′*, was oblique to the side of the forebay; by turning the handle, *l*, to the left, the fulcrum being at *m*, the end *l′*, and, (by means of the connecting rod, *l′*, *l″*,) the end *l″*, of the lever, *l″*, K, were turned to the right, which, the fulcrum of *l″*, K, being at *m′*, opened the gate at K.

Frame supporting the Wheel.

N, O, P, Q, represents the frame supporting the water-wheel: this frame was formed on one side of the wheel, (Plates II. and III.) by a double row of uprights, and on it the head block, *n″*, *n‴*, (Plate II.) was placed to sustain the plumber block, *o′*, on which one end of the axis of the wheel rested; on the other side, (Plates I. and III.) a single row of uprights braced from the floor, and connected at top and bottom, formed the frame; this was surmounted by the head block, *n*, *n′*, upon which rested the plumber block, *o*, carrying the axis of the wheel. This frame was disconnected from the forebay.

Reservoir for collecting and measuring the water used, Tail race, &c.

A reservoir, R, S, T, Q, (Plates I. II. and R, R, Q, Q, Plate III.) for collecting and measuring the water used in experiment, was made

by planking the interior of part of the frame just described; the sides and ends of the reservoir were carried to the height of six feet, and the floor was laid upon the cross-sills into which the uprights of the frame were tenanted.

This reservoir having been formed accurately into a rectangular prism, its capacity was calculated by measuring the length, breadth, and depth: to test the accuracy of the result, the reservoir was filled, up to a certain level, with water carefully weighed, the number of pounds which the whole reservoir would contain calculated, and found to differ but 20 lbs. in 30,000, from the weight obtained by means of the capacity.

To indicate the level of the water in this reservoir, with a view to determine the quantity used in any experiment, a hollow tin vessel, p, p', (Plate I.) was used as a float; a tube passed through the axis of the float, forming a stem, which was allowed to slide freely in a vertical direction upon an iron rod, or guide, attached to the bottom of the reservoir: the stem, q, q', of the float extended to a convenient height above the lower floor, N, O, and was graduated into divisions, each of which represented a quantity of water within the reservoir of 1000 lbs. in weight. A light bar of iron, r, $r,'$ was attached to the upper timber of the wheel frame, having at its upper end, r, a loop embracing the stem of the float; to this loop was affixed a sliding plate of brass, r, r'', the edge of which could readily be placed opposite to that mark, on the float rod, which might happen to be next above the loop; this mark then served as a point from which to estimate the quantity of water used in any experiment without, before commencing, actually emptying the reservoir. The number of divisions on the stem of the float which had passed the top of the slide during an experiment, showed within certain limits of accuracy, the quantity of water which had entered the reservoir; but for greater nicety of determination, a gauge plate minutely divided was applied to the top of the slide, by the use of which the quantity of water in the reservoir could be obtained to within 5 lbs.

The water after leaving the wheel was conducted through a slightly inclined tail-race, U, R, to the reservoir. To prevent agitation of the surface of the water, within the reservoir, which would have resulted from the fall of water introduced from the tail-way, a flume R, s, s', Q, (Plates I. II. and s, s, s', s', Plate III.) of a square section, was constructed, extending from the race nearly to the bottom of the reservoir, between which and the termination of the flume the water must necessarily pass; there was also a platform of light boards, nearly as large as the floor of the reservoir, placed within, which rose and fell with the surface of the water: these precautions so far preserved the float from oscillation, that the operator could obtain without delay by inspecting the gauge rod, the weight of water collected in the reservoir.

To empty the reservoir, a waste valve, t, (Plates II. and III.) was placed at one end; this valve could be opened by the lever, t', t''; (Plate II.) having its fulcrum at t''', acting upon the valve by the

intervention of the rods, $t' t^{iv}$, t^{v} t, (Plate III.) and lever t^{iv}, t^{v}; it was raised above the floor so that the reservoir might never be entirely emptied, and that thus a level would always be afforded from which to reckon the quantity of water which entered during any experiment.

As only the water used in experiment was to be admitted to the reservoir, a valve u, u', (Plates I. II. and III.) 15 inches in breadth, and in length equal to the breadth of the wheel, was placed in the floor of the tail-race; this valve when open, allowed the water from the wheel to fall into a trough u, u, v, v', v'', v''', (Plate III.) which conducted it on the outside of the reservoir, by the trunk w, w', (Plates II. and III.) to the waste trough. Guide boards were placed in the tail-way on each side of the valve, that all the water might pass through it when open. The closing and opening of this valve were effected by the action upon the stem x, x', (Plates I. and III.) of a series of levers, (Plates III. and II.) x', x'', y, y', y'', z, connected by vertical rods x'', y, and y', y'', and terminating in the stem z, z', on the side of the forebay shown in Plate I.; by means of a handle, z'', attached to this stem the operator on the first floor, N, O, O', was enabled to work the valve. When the valve was closed, the water flowed over it to the lower end of the tail-race, whence it passed, in the manner already described, to the reservoir. A bell, a, (Plate I.) attached by a spring to the stem z, z', ringing when the stem was moved, served to give notice of the closing or opening of the tail-way valve, that is of the beginning or end of an experiment. As in closing the valve, in commencing an experiment, the small quantity of water between it and the wheel, not used in the experiment, entered the reservoir, so on opening it, at the conclusion, an equivalent quantity of the water which had been used ran to waste.

The water carried up by the wheel when in motion, was returned to the tail-race by the guard, b, b', u', (Plates I. II. and III.) placed for this purpose, and conducted to the reservoir, or allowed to run to waste according to the position of the valve.

Water-Wheel.

V, W, U, X, (Plate I.) represents the water-wheel used during the first series of experiments; this wheel was 20 feet in diameter, and 20 inches in breadth, being 16 inches, in the clear, between the rims, or cants. The rims were attached to the arms in the usual manner. The axis of 12 inches in diameter, into which the arms entered, was surrounded, for a certain portion of its length, as shown in Plate III., by a barreling of 24 inches in diameter, the gudgeons, $3\frac{1}{2}$ inches in diameter, turning upon brass bearings, fitted into cast iron plumber blocks; the whole rested on the head blocks n, n', n'', n''', (Plates I. and II.) capable of sliding upon the upper beam of the frame supporting the wheel, by which arrangement the wheel might be removed from the breast when alterations were required.

On the inside of the head block, at n, Plate I., an iron pin was fixed, connecting two straps, also of iron, in the manner of a joint hinge; these straps embracing the barreling of the shaft had their ends, d and d', connected by a wooden lever, d', d'', turning upon a ful-

crum, d‴, equi-distant from the ends which the lever connected; the pin forming the fulcrum passed through a post attached to one end of the head block: by depressing the end d″, of the lever, d′, d″, the straps were caused to press against the barrel with such force as to regulate, at the pleasure of the experimenter, the retrograde movement of the wheel produced by the descent of the weight which had been raised in any experiment; by elevating the same end of the lever, the straps were removed from contact with the barrel, which was thus permitted to revolve freely.

The buckets of the wheel having been varied in the different experiments will be described in detail in an after part of this report.

Apparatus relating to the Measure of Effect.

Y, Y′, Y″, and Z, Z′, Z″, (Plates I. and III.) represent two masts, or heavy posts, one of which was stepped upon the ends of two adjacent cross-sills of the forebay, at Y, the other, at Z, upon a strong piece of timber, bolted to the side of the frame, supporting the wheel. From the cap, Y″, Z″, (Plate III.) connecting these posts, were suspended two iron pedestals, e, e′, and f, f′, in which, in brass bearings, turned the gudgeons of a roller, or drum, e′, f′; the gudgeons were 1 inch and $\frac{7}{8}$ths in diameter. The drum, 16$\frac{1}{4}$ inches in diameter, was covered with hoop iron, to prevent its abrasion by the chain which passed over it. The chain was attached at one end to the barreling of the shaft of the water wheel, and passing over the drum above, the other end, g, was fastened to a basket, g, g′, of iron in which were placed the various weights used in the experiments. To prevent inequality in the weight raised during any part of an experiment, from the winding of the chain upon the barrel, a similar chain, the lower part of which always rested on the ground, was fastened to the bottom of the basket.

The chain was kept from riding and chafing, as it wound upon the barrel, by depressing slightly the end f′, of the roller, thus giving the chain a tendency to move, in winding, towards the depressed end. The chain was brought back to its original position, at the higher end of the drum, during the descent of the basket, by inclining that part between the drum and barrel in an angle, to the axis of the drum, measured towards the elevated end, less than a right angle: to give this inclination a pulley, k, (Plates III. and I.) was fixed in an iron frame, k′, k″, capable of sliding in horizontal guide grooves; by drawing the frame towards l, the pulley was made to press against the chain effecting the object proposed. The iron frame, k′, k″, was drawn towards l, by a rope, one end of which was attached to the frame at k″, while the other passed over a fixed pulley, l, and was attached to an axle turned by the arms m, m′, and m, m″. The frame was carried back to the end, n, when the power ceased to be applied at the arms, m, m′, m, m″, by a weight n′, acting by the rope, n′, n, k′, passing over the pulley n, and attached to the frame at k′.

The measure of effect adopted was, as has been stated, the weight raised, and the height through which it was raised; to determine this

height a mark was fixed to the chain at a point convenient for beginning the experiments, and a second to serve as a point of termination. To enable the operator to judge accurately of the arrival of these points on a level with his eye, an indicator, p, p′, p″, (Plate I,) being a miniature crane, was attached to the side of the forebay frame, the horizontal arm being placed at the proper height above the lower floor O, O′; the habitual position of the indicator was, as shown in Plate I, with the horizontal bar resting against the forebay frame. Just before the arrival of the lower mark upon the chain, at the level of the indicator, it was turned at right angles to the side of the forebay; when the mark reached the indicator, the stem, *z*, *z*′, of the lever for manœuvring the gate in the tail race, was raised into the position represented in the figures, ringing the bell a; the ringing of this bell, and the closing of the tail-way valve, being simultaneous, the precise instant was thus marked at which the water began to be admitted to the reservoir. On the arrival of the second mark at the indicator, the stem, *z*, *z*′, was drawn down, by means of the handle *z*″, again ringing the bell, and marking the time of the conclusion of the experiment, namely, that at which the water was allowed to run to waste by opening the valve in the tail-race: the stem, *z*, *z*′, was kept in its new position, by inserting the baton q, beneath the lower edge of the rest, q′, q″.

A very accurate time-piece, with the dial graduated to half seconds, completed the apparatus.

Method of Conducting the Experiments.

A general statement of the methods of experimenting will now be given.

One person was stationed upon the upper platform, specially charged with regulating the head of water in the forebay: this he did by means of the levers *d*′, *g*, and *e*′, *g*′, (Plate I,) controlling the stop cocks, *b*, and *b*′, in the supply pipes, or when the level was too high, by letting off as much water as was required to reduce it, through the waste valve *k*, Plate II; the head was ascertained by the float *h*, (Plate I,) tape line, *h*, *h*′, *h*″, and index, *i*, already described. The same person being always employed in this duty was, by practice, enabled to preserve a required head, subject to a variation of not more than a quarter of an inch, during any one experiment. The same operator opened and closed the gates for letting the water upon the wheel, and regulated the position of the chain during the descent of the basket so as to bring it back to the elevated end of the roller, by turning the arms m, m′ and m, m″, connected by the rope l′, l, k″, with the slide, k′, k″, carrying the pulley, k, (Plate III.)

A second assistant was placed upon the lower platform, N, O, O′, (Plate I,) who had in charge the regulation of the break or friction strap, and the closing or opening of the tail-race valve, *u*, *u*′, for collecting, or suffering to run to waste, the water used by the wheel; he also placed the proper weights in the basket, allowed the escape of the water from the reservoir when necessary, &c.

A third person attended to note the circumstances of each experiment, to observe the time occupied, the quantity of water in the reservoir as shown by the gauge rod, and to make the necessary calculations.

When an experiment was to be made, the moveable plate r, r'', (Plate I,) of the reservoir gauge was set to the mark on the gauge rod next above the loop. One of the gates for letting the water upon the wheel, was then opened, and the wheel suffered to revolve, with a full supply of water, until the basket was raised sixteen feet; by this time all the moving matter had acquired an equable motion, and the first mark upon the chain coincided with the indicator, p, p'; at this instant the second operator closed the tail-race valve, in doing which he rang the bell, a, the signal for the third operator to note the time. The first operator now carefully kept the water in the forebay, at a constant level. The water used by the wheel passed into the reservoir, R, S, T, Q, until the second mark on the chain, coincided with the indicator, when the second operator opened the tail-way valve, at the same time causing the bell, a, to ring, thus giving notice to the third operator to mark the time, and to the first to close the aperture admitting water to the wheel, and to stop the influx of water into the forebay. The chain was then drawn back, by the pulley and slide described, as the weight descended retarded by the friction strap. By the time the weight had arrived at the lower platform, the surface of the water within the reservoir was at rest, the amount there collected was ascertained, and a memorandum of it placed upon the minutes.

[TO BE CONTINUED.]

On the Causes of some Explosions of Steam Boilers. By THOMAS EARLE. *Read before the Franklin Institute, February* 24, 1831.

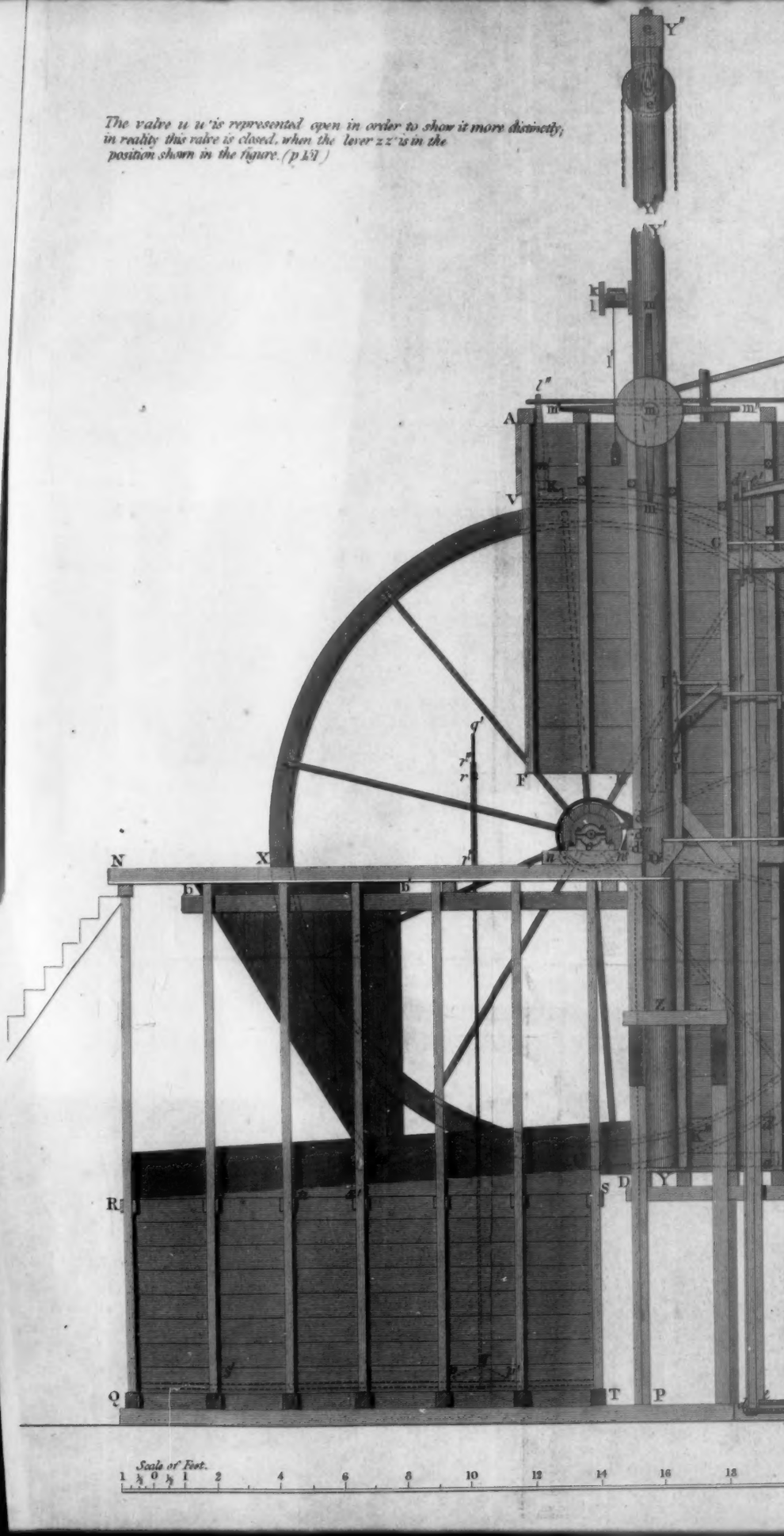
THERE have been several instances of explosions of steam engines, upon pumping additional water into the boilers, although the steam, before the addition of the water, had not shown a high expansive power. It is generally agreed, that immediately before these occurrences, the water has been very low in the boiler, the iron of the flue laid bare, and become very hot, and the steam also probably heated to an unusually high degree. But a doubt has arisen whether the heat that produces the great excess of steam, which causes the explosion, is borrowed from the hot iron, or from the hot steam previously in the boiler. The object of this paper is to endeavour to do something towards settling this question.

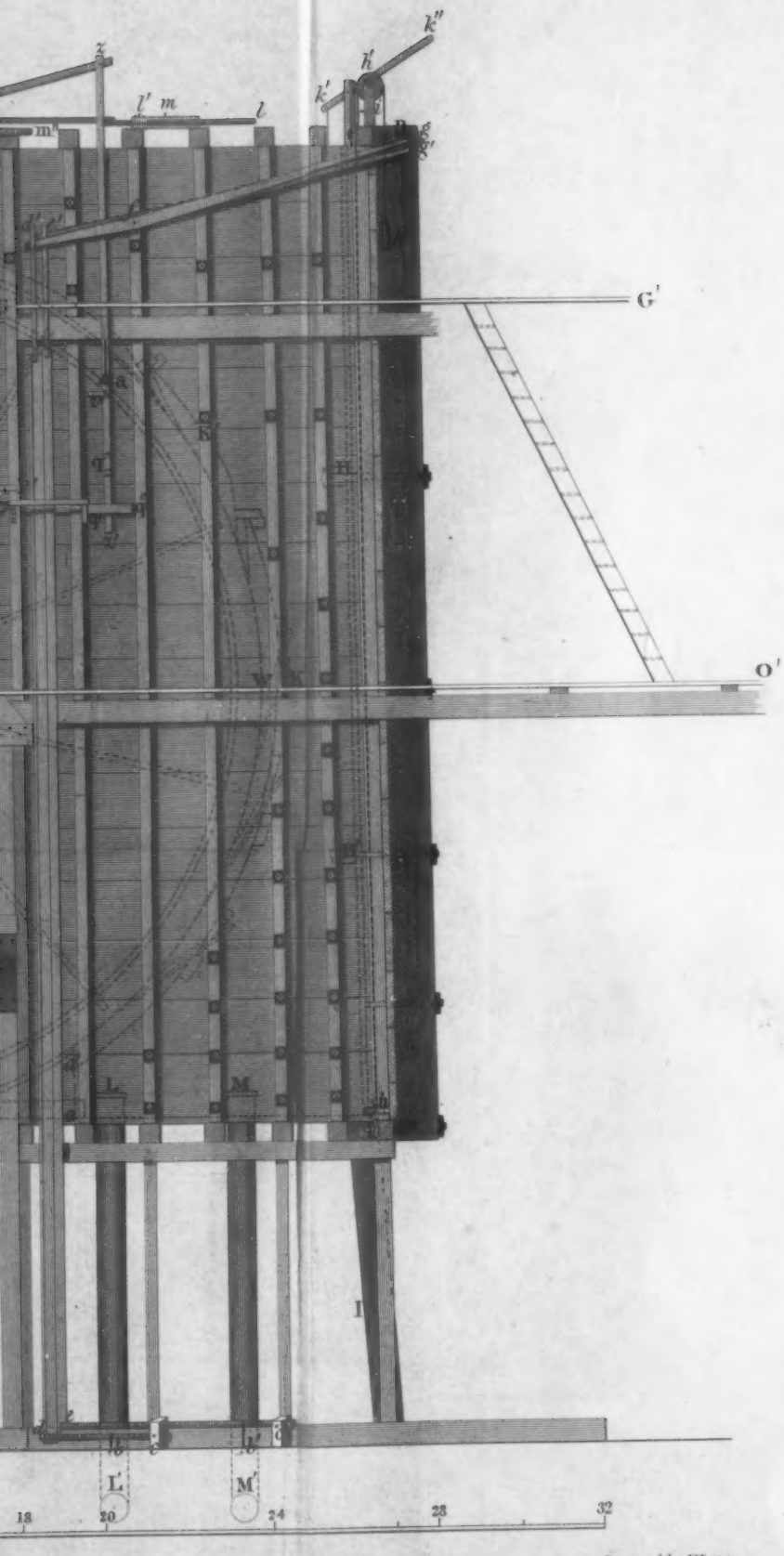
Question 1. If heat be borrowed from steam at a high temperature, to convert additional water into steam at a lower temperature, will the whole quantity of steam thus obtained possess more elastic force under a given volume, than belonged to the hot steam alone?

It is an ascertained law of steam and of all gases, that equal additions of temperature, give nearly equal additions of volume. It is also ascertained that gases and steam for each degree of heat they re-

k''
h'
k'

The valve u u' is represented open in order to show it more distinctly; in reality this valve is closed, when the lever z z' is in the position shown in the figure. (p 15)





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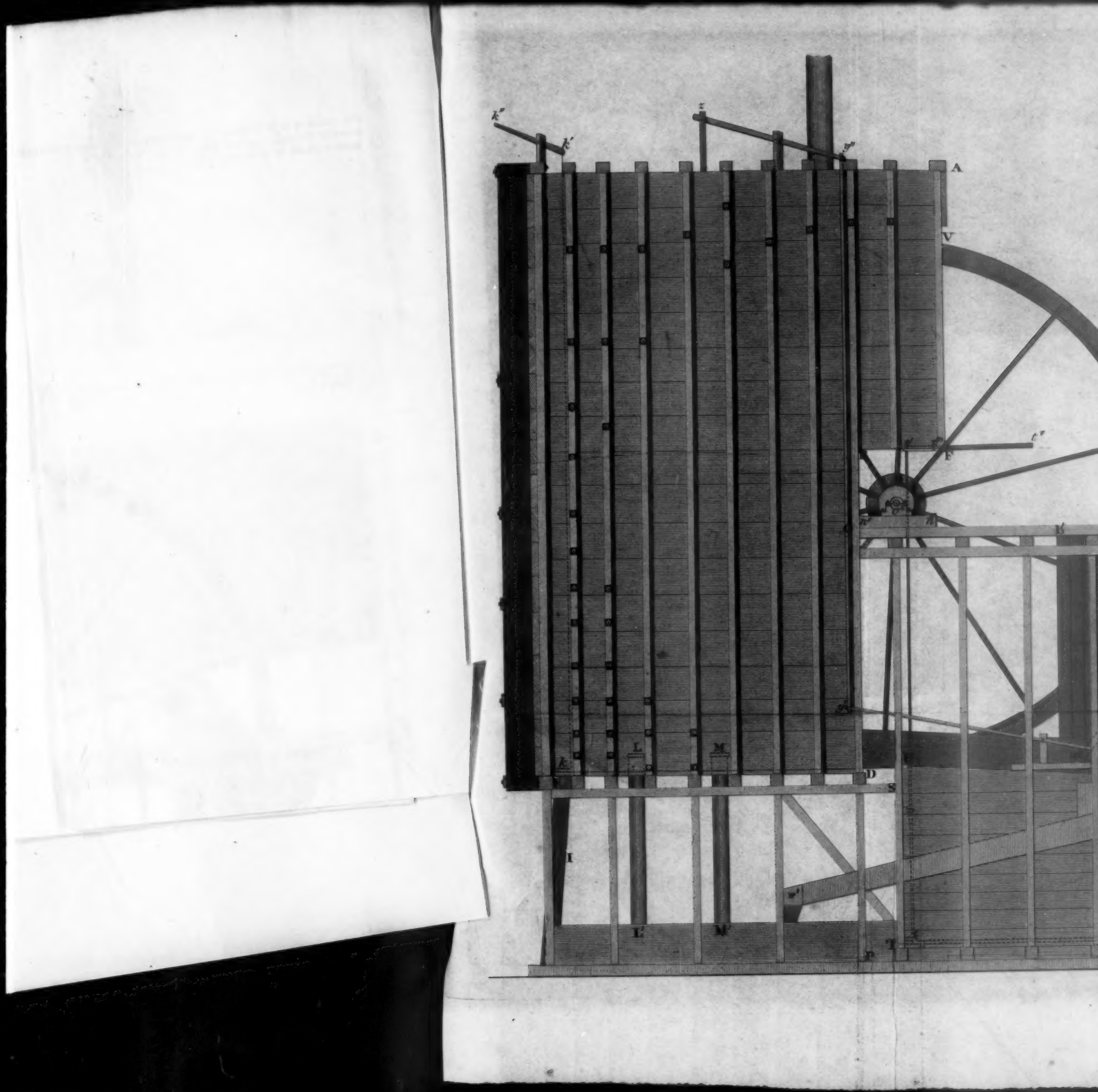
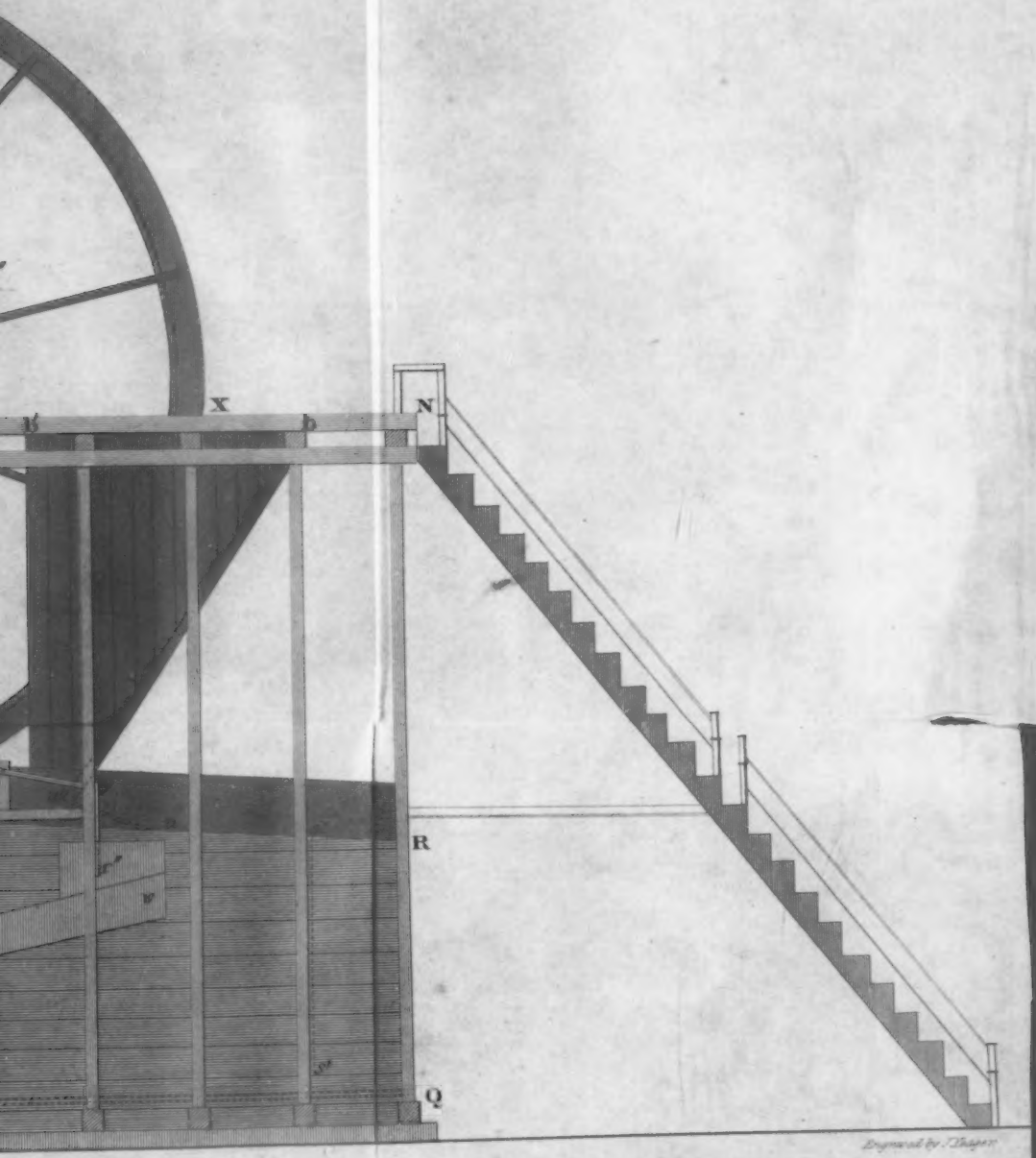

A
V
L
M
D
I
L'
M'

PLATE II.



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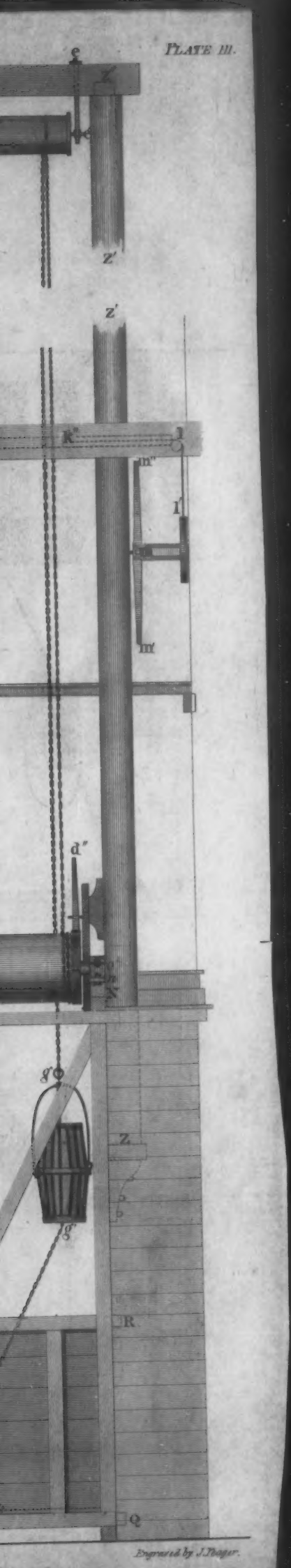
PLATE III.
e
Z
z'
z'
K"
J
n"
l'
m'
d'
g'
Z
g'
R
Q
Engraved by J.Thagar.

ceive, gain about $\frac{1}{480}$ of the volume they occupied at 32° Fahrenheit. This would give a gain of $\frac{1}{660}$ of the volume occupied at 212°, for each additional degree of heat above that point. Hence, an addition of 660 degrees of heat, should increase one volume of steam, at 212, to two volumes, under the same pressure, or should double its power.

Then if we have water at 212, and to 1 gallon, add 960 degrees of heat, we get about 1700 gallons of steam, under atmospheric pressure: then put 960 degrees more of heat and another gallon of water, we increase the steam to 3400 gallons: whereas if, in the last case, we had added the heat to the steam already made, 663 degrees would have sufficed to increase the steam to 3400 gallons. Thus 960 + 960 = 1920 degrees of heat, in the first case produced no more effect, than 960 + 663 = 1623 degrees do in the latter Heat added to steam *already formed*, is, therefore, more effective than the same quantity of heat added to hot water: and the theory of explosions from water converted into steam, by heat borrowed from other steam, cannot be true, unless the specific heat of steam be much greater than that of water, under equal weights; or, in other words, unless it takes a much greater absolute quantity of caloric to raise a pound of steam one degree, than it does to raise a pound of water one degree.

Dr. Crawford, from his experiments, inferred that the specific heat of steam was 50 per cent. greater than that of water. If this were correct, the effect of a certain quantity of caloric added to steam, or added to hot water, would be just about equal. But the more recent, and generally believed more correct experiments, of Delaroche and Berard, give a greater specific heat to water than to steam, in the proportion of 1,000 to 0,847. From this it would result, that heat added to steam, produces nearly double the effect which it would have done, if employed to generate more steam. On the whole, assuming as correct either Mr. Crawford's conclusions, or those of Delaroche and Berard, explosions cannot be produced by pumping even water at 212 degrees into highly heated steam, without the aid of some other cause.

Question 2. Can explosions be produced by pumping water on red hot iron?

The specific gravity of iron compared with water is as 7.788 to 1,000, say as 8 to 1; and the specific heat of hot iron compared with water under equal weights is as 0.1255 to 1: say as 1 to 8.* It takes about 8 times as much caloric, to heat a pound of water one degree, as to heat a pound of iron one degree: but about equal quantites to heat a given *measure*, say one cubic inch, of each substance. Consequently a cubic inch of iron at 300 degrees, on being reduced to 250 degrees, parts with nearly 1700 times as much heat, as a cubic inch of steam at 300, reduced to the same degree: and a cubic inch of

* Some experiments tend to show the specific heat of iron, compared with that of an equal weight of water, to be as 1 to 9. The difference, however, is entirely immaterial to the purposes of this essay.

red hot iron at 1172 degrees, has heat enough to convert one cubic inch of water into 1700 cubic inches of steam.

Hence it appears extremely easy to produce explosions from throwing water on hot iron, as indeed is proved by Perkins' steam gun. If that gentleman's generators had been no stronger than ordinary boilers, they would have been destroyed by one-third of the power which he produced by throwing water on their red hot iron: and strong even as they were, they would have exploded had he pumped in a sufficient quantity of water, without giving vent to the steam produced.

A cubic foot of hot iron by being reduced to 32 degrees, would furnish heat sufficient to convert a cubic foot of ice cold water into 13,600 gallons of steam, at atmospheric pressure: and a single square foot of boiler-iron, $\frac{5}{16}$ of an inch thick, if only at a bright red heat, has caloric enough to make 88 gallons of steam. It is probably not very uncommon for boilers to become so destitute of water, that 10 or 15 square feet become red hot. This surface, by losing only half its heat, would produce steam enough in addition to that already existing, to explode almost any boiler.

The sudden cooling of a part of the boiler, no doubt weakens it very much, and hence we find some boilers in their rupture following the water line, which line was probably made by a fresh supply of water, or by a motion of the steam boat raising the water upon the heated iron of one side.

The explosions which have occurred about the period of coming to, or leaving a wharf, may be attributed to the boat's being thrown partly on one side, either in turning, in striking the wharf, or under the weight of passengers shifting their position, so that the water is thrown upon hot iron of the boiler.

The conclusion to which I come, is, that a considerable proportion of the explosions which occur, is occasioned by water being thrown on highly heated iron. The proper preventives, are, care in engineers, and such construction of boilers, that the part exposed to the greatest heat will not be soonest laid bare, nor a large surface either suddenly laid bare, or suddenly covered by water: also to throw the water into the bottom of the boiler, rather than by a jet into the upper part.

FRANKLIN INSTITUTE.

Monthly Meeting.

The stated monthly meeting of the Institute was held at their Hall on Thursday evening, February 24, 1831.

Thomas Fletcher, vice president, in the chair.

The minutes of the last meeting were read and approved.

The following donations were presented to the Institute, viz.

By Mr. A. B. Hutton.

The Mechanics' Journal, or Artisans' Miscellany of Inventions, Experiments, Projects, and Improvements in the useful Arts.

By Mr. Zachariah Allen.

The Science of Mechanics as applied to the present improvements in the useful Arts in Europe and in the United States.

By Mr. Josiah Copley.

Letter from the Secretary of the Treasury, transmitting the information required by the House of Representatives in relation to the growth and manufacture of Silk, adapted to the different parts of the Union.

By the Board of Managers of the Institute, for 1830.

Précis, Elémentaire de Physique Expérementale, par J. Biot, Vols. 1 and 2.

By Professor A. D. Bache.

Catalogue of the Officers and Students of the University of Pennsylvania, January, 1831.

The corresponding secretary laid on the table the following works, received in exchange for the Journal of the Institute, viz.

The Mechanics' Magazine, and Journal of Public Internal Improvements, for January, 2 *copies.*

Journal of the Philadelphia College of Pharmacy, for January.

American Annals of Education and Instruction, and Journal of Literary Institutions, for February.

The Magazine of Useful and Entertaining Knowledge, for January.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale, for August, 1830.

Professor A. D. Bache stated, on the part of the committee on explosions of steam boilers, that the preparatory arrangements for experiments had been made, and apparatus for further prosecuting the objects of their appointment was in progress.

Professor Johnson from the same committee stated, that the committee had taken measures to obtain specimens of American iron for the purpose of experimenting on the strength of the different kinds of that material employed in the formation of steam boilers.

Mr. D. H. Mason made some remarks on the application of the power of steam engines to locomotive carriages.

Thomas Earle, Esq. read a paper "on the causes of some Explosions of Steam Boilers," which, after some remarks, was referred to the committee on publications.

The following queries were proposed for discussion, and ordered to be entered on the minutes.

1st. The subject of rapid and slow motions of boats in abrading the banks of a canal.

2nd. What are the relative advantages of stationary and locomotive power, in propelling carriages on planes of any elevation?

3d. What are the best means of securing the boilers, cylinders, and all other parts of steam engines, whether employed for stationary purposes, for navigation, or for locomotive carriages, against loss of power by radiation and conduction?

THOMAS FLETCHER, *Vice President.*

J. H. BULKLEY, *Recording Secretary.*